THE AMERICAN GAS-LIGHT JOURNAL AND CHEMICAL REPERTORY

Publishing Office, No. 42 Pine Street.

DEVOTED TO THE INTERESTS OF ILLUMINATION, VENTILATION, WATER SUPPLY AND DISTRIBUTION, & GENERAL SCIENCE.

VOLUME XXV.—No. 5. Whole No. 413 | NEW YORK, SATURDAY, SEPTEMBER 2, 1876. | $3 PER ANNUM IN ADVANCE.

A. M. CALLENDER & CO., Proprietors.
G. WARREN DRESSER, Editor.

CONTENTS.

☞ An asterisk (*) denotes an illustrated article

TORIAL—
To the Members of the American Gas-Light Association..... 109
The American Gas-Light Association..... 109
The Semi-Annual Meeting of the New England Association of Gas Engineers..... 110
A Correction..... 110
ish Association of Gas Engineers..... 110
antitative Analysis of Coal Gas..... 111
Analysis..... 111
Manufacture of Coal Illuminating Gas..... 112
sh Associations of Gas Managers..... 113
"Pipe-Founding Contract..... 115
respondence—
Letter from Mr. Somerville..... 116
Is Cement a Corrodent..... 116
The Amount of Light Obtained from Coal..... 116
sian Economy in Rails..... 116
Light Intelligence..... 117
mical and Scientific Repertory..... 117
ining and Oil Tanks..... 117
Mechanical Action of Light..... 118
Hudson River Tunnel..... 118

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All communications to be addressed to **"The Proprietors,"** No. 42 Pine Street, Room 18, New York.

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TO THE MEMBERS OF THE AMERICAN GAS-LIGHT ASSOCIATION.

OFFICE OF THE AMERICAN GAS-LIGHT ASSOCIATION,

117 BROADWAY, NEW YORK, Aug. 31, 1876.

The Fourth Annual Meeting of the AMERICAN GAS-LIGHT ASSOCIATION will be held in the city of New York on the third Wednesday of October (the 18th) 1876.

CHAS. NETTLETON, SECY.

THE AMERICAN GAS-LIGHT ASSOCIATION.

As will be seen by the notice published above, the call is out for the Fourth Annual Meeting of this Association, and it is to be hoped that the attendance will be full, and that the best men in the business will this year make a special effort to be present, and not only that—but to take a part in the proceedings.

Of the importance of these meetings, if they are conducted in accordance with the spirit of the constitution of the organization, it would seem almost unnecessary to speak; yet it cannot be overestimated, and it behooves all interested in the true progress of the Science of Gas Making to do their part towards making the next meeting of a somewhat different character from former ones. If the proper course is pursued the benefits to be derived will be not only immediate, but will have much influence on the future of the Association and the business interests that it represents.

At the Fifteenth Annual Meeting of the North British Association, held in Edinburgh, last July, the President, in his opening address, after giving a concise history of the organization and progress of that Society, said—

"It is not too much to say that the gentlemen who proposed these Associations, and carried out their union, could hardly have imagined that the united Association would have risen to the importance it has, or that it would have given birth to so many others—in all parts of the country, on the Continent, and in America—having the same objects in view, viz.: the advancement of the science of gas manufacture."

The North British is the oldest, and we quote the above to show that the doings of the younger branches are watched and recognized by the parent Association. It behooves us for our own credit, if for nothing else, to put our "best foot forward," and to show the world that we are worthy of our parentage.

Mr. Stewart, the President, further says—

"When one looks back even only as far as 1862, and observes the advance that the manufacture of gas has made, not so much in any radical changes in the process of manufacture, but in the amount of scientific knowledge that is now applied to it, and the dispersion of many crude and imperfect notions which only led men to dogmatize, and think no one could be right but themselves, and the great reserve that even then prevailed as to what each did, and compare that with the free exchange of opinion, the open manner in which all new inventions are brought forward for examination, and the scientific care and watchfulness that are applied to every department of manufacture, he must at once recognize a great change for the better; and I think it cannot be denied, or be a matter of doubt, that this improved state of affairs has been the result of the labors of this and kindred Associations. That the future of this and similar Associations will not be one of retrogression is certain, from the great mental activity now given to every department of gas manufacture. For instance, the careful attention shown in the analyzing of coals; the desire to ameliorate or lessen the manual labor in retort-houses; or to curtail the waste of gas in charging retorts, by the invention of retort-charging machinery and self-closing lids; the eliminating from the tar of all its permanent illuminating constituents; the introduction of exhausting by the direct action of steam, without the use of expensive machinery; the attention given to the reduction of labor and cost in purification by the introduction of a continuous process; the more elaborate utilization of the residual products; the control of the distribution of the gas by the introduction of governors constructed upon improved principles; and the improvement in many details of minor parts of gas apparatus, having in view economy in the manufacture. But in the future, as in the past, our efforts must still be directed to the economy of labor, the economy of fuel, the converting of all our impurities and waste product into saleable manufactures, by which the item of purification will cease to be one of cost, but become an item of profit."

Here we have the testimony of one long connected with the oldest Association in Great Britain as to the value of these meetings, and we may refer to one point alluded to, for it appears to be the vital one after all, and that is "the great reserve that prevailed as to what each did,"

In order to know whether progress is being made or not, one thing is certain—that it must be first known exactly what each is doing.

It is only by comparison of results that any correct conclusions can be drawn, and what is needed most is some form of REPORT OF WORKINGS by which such items as can be given may be brought together and tabulated, so that a glance will show just what progress is being made from year to year. This matter has been referred to before in these columns, and it is to be hoped that the next meeting will adopt some course to secure this all-important starting point.

Having done this, the forms may be sent to each company to be filled up and returned to the proper officer for compilation and distribution to the companies again.

Another thing naturally suggests itself, and that is that, as far as possible, the business of the meeting should be arranged upon some basis so that there would be a definite programme established that all would understand. One trouble at previous meetings seems to have been that they have, to a certain extent, arranged themselves; and the discussions have been of rather a "hap hazard" nature. A certain number of subjects should be presented for discussion, and time allotted to each, according to their importance, a reasonable amount of time being reserved for miscellaneous subjects that may present themselves at the time. In short, the meeting, in order to result in the most benefit possible, should be conducted *systematically* and in a business-like manner. It is not the place to "grind axes," but to give and receive instruction that shall result in enabling the members to advance the scientific and practical interest of gas manufacture.

THE SEMI-ANNUAL MEETING OF THE NEW ENGLAND ASSOCIATION OF GAS ENGINEERS.

The New England Association of Gas Engineers held their semi-annual meeting at Portsmouth, New Hampshire, on the 15th and 16th of August. It is the design of the Directors of the Association to make the summer meeting more of a social than a business gathering, and as such the one held last week was a decided success. The Association were peculiarly fortunate in their selection of a place of meeting, for it combined many things essential to the comfort and enjoyment of the members. In the first place—a most excellent hotel, the Rockingham, kept by a most excellent landlord, Mr. S. W. Hilton, by whom everything was done for the entertainment and comfort of his guests. In the second place—the quiet respectability of the town seemed to impress itself upon all and, in addition, the cool sea breezes served to refresh every one who was able to escape from the heat and smoke of his works to spend a few hours with his fellows in business, and to become better acquainted each with the other.

A business meeting was held on the first day, during which some very interesting and instructive remarks were made by Mr. Price, President of the Cleveland Gas Company. Many valuable facts were brought out in the informal discussion of various matters of interest to those present. On the second day an excursion was made to the "Isles of Shoals," and after returning from this the company sat down to a splendid banquet prepared by the host.

Many pleasant things were said, and the whole affair passed off in a most satisfactory manner. It has been urged by some that the semi-annual meeting of the Society was of little use, but every one who was present at this meeting must have seen the error of this idea. The relaxation and benefit derived from getting away from one's own shop, and meeting others and comparing notes, is of itself enough to repay all who attend.

The greatest want that manifests itself in all these meetings, is a systematic system of reports of operations, by which it can be seen at a glance just what is being done at different works as regards yield, illuminating power, purification, coke used in furnaces, coke sold, residual products, etc., etc.

It is to be hoped that at no distant day some form of report may be devised that all will be willing to adopt, and fill out each year, similar to those used abroad, so that tabulated facts may be collected, and points where improvements may be made will suggest themselves readily.

It is only by comparisons like this that one's actual workings can be determined. What would have been considered, for instance, a few years ago a good yield would now be looked upon as a poor one.

The benefits to be derived from these Associations, when they are properly conducted for the purposes for which they are organized, are incalculable; and it is to be hoped that others will be formed in the different parts of our country so that their benefits may be extended.

A CORRECTION.

The London *Journal* of August 8th publishes a letter from Mr. Mann, referring to some retort settings used in some works in this country, and, inadvertently no doubt, speaks of Mr. Stanley, the inventor of the Stanley Main, as the engineer of the New York Gas Company.

Mr. Charles C. Mowton is, and has been for years, since the death of his father, the incumbent of that responsible position: and, doubtless, no one will be more happy than Mr. Mann to make the due correction as soon as he is aware of the error in his statement.

British Association of Gas Engineers.

[From Report in London "Journal of Gas-Lighting."]

Mr. F. W. Fison, of Ilkley, read the following paper on—

A NEW SELF-REGULATING EXHAUSTING APPARATUS.

In all large gas works the exhauster is considered as necessary a part of the plant as any other portion of the apparatus required for the manufacture of coal-gas; it is, therefore, unnecessary for me to enter into the great advantages that gas works which possess an exhauster have over those which do not.

The power required to drive an exhauster, relatively to the make of gas, is not great, and a small steam-engine is almost universally employed. This, however, necessitates a boiler, and constant attention is required, day and night, to keep up the steam pressure. It, therefore, results that in gas works of any but large size, an exhauster is but rarely met with, on account, not so much of the first outlay, as of the skilled labor afterwards required for it, and the constant attention which is necessary to keep up the steam in the boiler day and night.

The exhausting apparatus which I am about to describe has been designed with the view of obviating these difficulties, by dispensing, in the first place, with the steam engine and boiler; and secondly, by requiring but little attention, by reason of its being self-regulating. In fact, while being applicable to the largest works, it will meet the want which has been long felt by managers of works of a moderate size.

The power I make use of to drive the machine is Otto and Langen's atmospheric gas engine, made by Crossley Brothers, of Manchester, a motive power which has now come into very general use. The exhauster itself may be any one of the pumps in ordinary use, either reciprocating or rotary; in my own case the exhauster is of Beale's pattern, made by Gwynne and Co., Essex Street, Strand. But I would have it borne in mind that the arrangement is equally suited to any form of exhauster.

In the usual form of self-regulating exhauster driven by steam engine, the rate of flow of gas is regulated by a throttle-valve on the steam-supply pipe moved by a governor connected with the gas. The gas-engine, however, runs at a constant speed, unaffected by the quantity of gas supplied to it; or, in other words, the regulation of the gas supply to the engine would not affect the speed of the exhauster. It is, therefore, necessary to convert this constant speed of the motor power into the ever-varying speed of the exhauster consequent upon the rate of "make" of the gas. This is effected in the following manner:—

Between the engine and exhauster is inserted a pair of what are commonly called "speed cones," and the rate at which the exhauster runs is dependent upon the position of the belt on the cones. Between these cones, and parallel to their axes, is a screw carrying a nut, upon which is fixed the guide-hook for the drawing-belt, so that the rotation of the screw to the right or left (by altering the position of the belt) increases or decreases the speed of the exhauster; it is by means of this screw that the regulator indirectly acts. Upon one end of the screw is fastened a large friction-wheel, with a V groove cut into its rim. Immediately above it are two small friction-wheels, with edges turned to fit the V groove of the large wheel. These two wheels are carried on a lever turning upon a stud at its centre, and are so placed that when the lever is horizontal, both wheels, though close to it, are free from touching the large friction-wheel at the end of the screw; when, however, either end of the lever is depressed, the corresponding wheel is pressed into the large friction-wheel. These two small friction-wheels are connected with the driving cone by means of a belt and gearing, and they revolve in opposite directions; in short, when one end of this lever is depressed, rotation from right to left is communicated to the large friction-wheel, and consequently to the screw and belt guide, and when the same end of the lever is raised, rotation is communicated in the opposite direction. The small friction-wheels can be set so close to the large wheel, that a motion of less than half an inch, up or down, of the end of the lever, serves to put the screw in rotation in opposite directions respectively. We have thus arrived at a means whereby a very small movement of the lever can cause the speed of the exhauster to be increased or diminished. It is upon this lever that the regulator or governor in connection with the gas on the retort side of the exhauster directly acts. This regulator, for altering the speed of exhauster according as more or less gas is being made, consists of a modified form of governor, in which care is taken to reduce the friction of the working parts as much as possible. The diameter of the bell of the regulator is 24 inches; upon a bell of this size a difference of gas pressure of 1-20th of an inch of water (that is half a "tenth") exercises a force, upwards or downwards, of about three-quarters of a pound weight. Therefore, as the moving friction of the regulator is much reduced by its construction, and as the friction-wheels re-

quire but little pressure (5 or 6 ounces at the end of the lever being sufficient) to cause them to act on the large wheel, a difference of half a "tenth" in the pressure of the gas is quite sufficient to cause the speed of the exhauster to be altered. A contrivance is added to the regulator to prevent it being unduly sensitive, or, to describe it more clearly, to prevent the exhauster "racing"—that is, pumping too fast and too slowly alternately.

In conclusion, the working of this machine is most satisfactory. It keeps, without requiring any attention, the pressure of the gas in the retorts within a limit of a "tenth" of water. Its working is very economical, and it can be started and stopped at a moment's notice without any previous preparation.

Mr. Mead, of Reigate, expressed the satisfaction he felt in listening to the paper, and with the evident attention and careful study which the author had paid to the subject dealt with. In the first place he took care in balancing his governor, by mounting his bearings on a knife-edge to save friction: in the next place he availed himself of the cone adjustment; then he devised a most ingenious means of friction-pulleys, by which he brought the cones into exercise when necessary. There was nothing to get out of order in the apparatus; it was simple in itself, and he (Mr. Mead) would undertake to say it was most efficient for the purpose its inventor designed it.

Mr. D. Bruce Peebles, of Edinburgh, said some three or four years ago he had the pleasure of being introduced to Otto and Langen's gas engine. It was employed by a friend of his, in Glasgow, to drive a lithographic press by, and he was much interested in witnessing its action. What he paid particular attention to was, first, as to its economy, and secondly, as to its efficiency in maintaining a constant power. He sent a meter to the place for the purpose of ascertaining what was the expense of working the engine. It was a half-horse power engine, and he found that the cost of working it was 1½d. per hour for Glasgow gas. The idea of employing such engines for working gas-exhausters was a most important and interesting thing for gas managers. The point had been established that the engine would supply a power to be depended upon, and next that it gave very little trouble, and was a very small expense. He had every reason to think that it would prove a very efficient instrument.

Mr. Fison said the fact of this engine having been in use four years enabled him to say that it was now 30 per cent. better than it was at the time it was made. He should be very glad if any one would try this arrangement on a large scale, as he had neither time nor opportunity to introduce it himself.

Qualitative Analysis of Coal Gas.

The examination of coal gas for the presence or absence of the various compounds generally found in the purified and unpurified material is, in most cases a matter of comparative simplicity, and it is only under circumstances where it is necessary to make a quantitative examination that any great amount of manipulative skill is necessary. With a comparatively few test solutions, some test papers, beaker glasses, and a Cooper's tube, or an ordinary eudiometer tube, the gas manager is in a position to apply all necessary tests to either pure or impure gas. The compounds for the presence of which it is generally necessary to test are comparatively few in number, and the method of testing extremely simple. Of these compounds the most important are carbonic acid, sulphuretted hydrogen, and ammonia. Besides these it may sometimes be desired, in particular circumstances, to test for other substances, such as carbonic oxide, oxygen, carbon disulphide, acetylene and heavy hydrocarbons generally, and sulphocyanides. In some cases, such as in examination for carbonic oxide, oxygen, or heavy hydrocarbons, it is, as a rule, not possible to make a purely qualitative test, as the presence of either of these substances is usually ascertained by observing the diminution in volume suffered by a measured quantity of the gas under the action of special reagents, and it is for this reason that a Cooper's tube is always an indispensable addition to the ordinary test apparatus. We shall now detail, successively, the more usual methods of testing for the presence or absence in gas of the various substances which have been enumerated.

Carbonic Acid.—The qualitative test for the presence of this substance in gas is invariably a clear solution of caustic lime, obtained by agitating some lime in a bottle with a quantity of distilled water. The water takes up a certain quantity of the lime (1-778th by weight), and, after the excess of lime has settled, the clear supernatant liquid is ready for use as required. In use, a quantity of the lime water is poured into a clean glass, and the gas to be tested is then allowed to bubble through the liquid for several minutes, when, if carbonic acid is present, a milkiness will be produced, the liquid becoming eventually more or less opaque in proportion to the amount of carbonic acid present. In applying the test, it is desirable not to pass more gas than is necessary, as the precipitate of carbonate of lime is, to a certain extent, soluble in an excess of carbonic acid, and the test liquid, after becoming turbid, may subsequently become partially clear again, and thus, perhaps, give rise to an erroneous estimate of the proportion of carbonic acid present in the gas.

Sulphuretted Hydrogen.—The usual test for presence of sulphuretted hydrogen is by means of strips of bibulous paper, moistened with a solution of lead acetate (sugar of lead). Under the action of sulphuretted hydrogen the paper becomes more or less rapidly blackened, whilst with perfectly pure coal gas no discoloration occurs. In applying the test, a jet of the gas is either allowed to impinge on the test-paper for a few minutes, or, if a more severe test be considered necessary, the moistened test-papers are suspended in a bell-glass apparatus, through which a continuous current of gas may be passed as long as may be desired.

Ammonia.—Moistened turmeric, or reddened litmus paper, may either be used as a test for ammonia, the former becoming brown, and the latter blue, under the influence of coal gas containing this impurity. This test may also be applied in an apparatus similar to that used for sulphuretted hydrogen, and the gas passed continuously as long as is necessary. A far more delicate means of detecting ammonia is by the use of the Nessler test. If the gas be allowed to pass for a short time through pure distilled water, and a little of the test subsequently added, a brown coloration, more or less intense, is produced in the event of ammonia being present.

Carbonic Oxide.—In order to test for the presence of carbonic oxide, it is necessary to fill a Cooper's tube with the gas to be examined. Any carbonic acid present must then be removed by agitating the gas with a little potash solution, and the latter being displaced by clean water, an excess of a strong solution of subchloride of copper is added, and the whole agitated. The copper solution being displaced by clean water, the gas is again shaken up, with a little potash solution to remove any fumes of hydrochloric acid. Any diminution in volume which the gas has suffered under the action of the subchloride of copper is due to carbonic oxide. It may, however, be stated that the test is far from satisfactory.

Oxygen.—The most convenient absorbent of oxygen is the alkaline pyrogallate of potash. The Cooper's tube is filled with gas, any carbonic acid removed by treatment with potash solution as before, and a small quantity of pyrogallic acid then added, and the whole agitated. Any oxygen present is then absorbed, the solution of the alkaline pyrogallate at the same time assuming a deep brown color.

Carbon Disulphide.—The presence of this substance in gas is generally proved by the production of sulphurous and sulphuric acids by the combustion of the gas. A very ready test for carbon disulphide is to pass the gas through a red-hot tube, filled with fragments of pumice, when the presence of the disulphide is revealed by the production of sulphuretted hydrogen. An ethereal solution of tri-ethyl-phosphine was suggested by Hoffman as a test for carbon disulphide, with which it unites to form a compound, appearing as a net-work of ruby-red crystals. This test is stated to be exceedingly delicate.—*London Journal of Gas-Lighting.*

Gas Analysis.

Sir: Seeing in the last issue but one of your *Journal* a complaint from "Micawber, jun.," to the effect that his inquiries on the question of Gas Analysis still remain unanswered, I think I may perhaps be able to help him out of his difficulty.

The barometric and thermometric corrections of gas as applied to lighting power are necessary for the maintenance of a uniform standard. In questions involving weights or volumes of gases, it has always been the custom of scientific men to correct to a uniform standard of 30 inches barometer and 60° temperature. If no such corrections were made, it is obvious that we could have no absolute standards of comparison, for data obtained with gases at one temperature and pressure would be different from those obtained under altered conditions. With regard to lighting power, it is customary at all the London gas-testing stations to make the report of illuminating power on the corrected volume of gas—that is, on the volume brought to the standard temperature and pressure, and for this purpose tables are provided by which the desired correction can be made with facility. Such correction will frequently make a difference of half a candle. "Micawber, jun.," will doubtless understand the question better if we assume an example in illustration. Let us assume that gas leaves the works at a temperature of 60° Fahr., but that the room in which it is subsequently tested is of a higher temperature—say, 70° Fahr.—it is obvious that 5 cubic feet of gas at 70° would, by reason of the expansion of volume having diminished the density, afford less lighting power than an equal volume of the same gas at 60° Fahr,, and unless a correction were made an injustice would be done to the company, who, sending out gas of one lighting power, would have it subsequently reported of a lower quality. A reverse in the supposed conditions would, of course, have an equally unfair effect, but in an opposite direction.

Any further information on the subject which "Micawber, jun." may require, I shall be happy to communicate.

"Chemicus."

——*Correspondence London Journal of Gas-Lighting.*

The Manufacture of Coal Illuminating Gas.*

By Alfred P. Trautwein, M. E.

Continued from page 91.

In the present paper it is proposed to examine and discuss, as fully as our limited time and space will permit, the various operations and the machinery and apparatus employed in the manufacture and distribution of coal illuminating gas. Although the primary object is to review it from an engineering rather than a chemical point of view, yet the chemistry of gas-making, playing, as it does, so important a part in the process, will also receive its due share of attention whenever it is deemed necessary.

It is also proposed, in order to give the paper a thoroughly practical and convenient shape, to examine particularly the machinery and apparatus of a gas works of a given definite size, and to arrange the problem in such a manner as to involve as many as possible of the conditions which are liable to come up in actual practice.

We shall be compelled, however, to limit our observations on gas manufacture, and gas works construction, to the methods practiced in this immediate vicinity. These differ in many respects from the methods adopted abroad, and even in many sections of our own country. This remark will, to some extent, serve to explain many instances of apparent conservatism in regard to much new and improved machinery and apparatus, the discussion of which is omitted in this paper, simply because no opportunities presented themselves for examining their construction and operation.

An attempt will finally be made to furnish estimates of cost of the machinery and apparatus in the projected works, and of the subsequent running expenses of the technical portion of the same.

In making a "design" for a gas works—if we may be permitted to apply this term to a case where it is not intended to go into general details—certain definite data and conditions are invariably given; the population, area, contour and general character of the city which it is proposed to light with gas; the amount of capital and of real estate which may be invested—these, and a number of similar conditions, varying of course in every instance, are rigidly prescribed and the design must be accommodated, if not to all, to as many of them as possible.

In this particular case, on the other hand, where data like the above were not given, it became necessary, in order to make the problem as thoroughly practical as possible, to supply them as best we could.

The problem, then, as here assumed, may briefly be stated as follows:

It is required to furnish a gas works for a city of some 65,000 inhabitants, located in the State of New Jersey, somewhere between New York City and Philadelphia. It is a manufacturing town of some importance, but is not very densely populated. The area, which is to be lighted at present and most probably for a series of years to come, is approximately that of a semi-circle about three and a-half miles in diameter, corresponding to 4.8 square miles.

Now, the maximum daily consumption of gas in our American cities has been found to vary from 3 to 12 cubic feet per capita. For obvious reasons this consumption is comparatively greater in the larger cities; it is determined, to a great extent, by the quality of the gas, and, above all, by the price at which it is furnished; in many of our smaller towns, also, the time of lighting the public lamps is limited to certain hours of the night, varying with the different phases of the moon; it is influenced finally, and to no small extent, by the position which the gas companies assume in relation to the consumers.

We shall probably be on the safe side, if we base our calculations as to the size of the projected works upon a daily consumption of 7.5 cubic feet per capita, corresponding to a maximum of 500,000 cubic feet in 24 hours.

In projecting a gas works for a city of some importance, it is usually customary to make the actual capacity equal to twice the present maximum, and it is supposed that the works will be rebuilt after 10 or 12 years. In our case, however, the question of whether or not, the city is a growing one, and, if so, to what extent, was left out of the problem. It depends upon so many purely local conditions, that it was deemed advisable not to take it into consideration, beyond providing for the duplication of the present plant at any time, if such a course is thought necessary, and making the general arrangement of the buildings accordingly.

In regard to the topographical character of the town, it is assumed, that the difference between the extreme high and low levels is 28 feet; that a navigable river or a canal running north and south, forms one of the boundary lines of the city; that the terminus of a railway is at the northern end, which railway then runs directly east. The lowest level is at the southern end of the town, being at a point one mile to the east of the said river or canal. The high level on the other hand, is at or near the northeast end, and about one-fourth of a mile south of the railway. The city then gradually slopes toward the river and railway.

Nothing was assumed in regard to the amount of capital at our disposal; it involves too many questions of detail, and then, again, the kind and style of the several buildings (which will not here be discussed) affects this to a greater extent than does the plant proper itself. The site for the proposed works shall not, if possible, be greater than 450 by 300 feet.

It is finally assumed that there will be a market for 60 per cent. of the coke, and for all of the ammoniacal liquor produced in the works, while there will be no sale for the tar.

These data being given, the site for the projected works should now be determined; and, in order to do this satisfactorily, it might be well to examine more fully the elements which the proper location of a gas works involves.

General principles of selecting a site.

The selection of the site is governed by very nearly the same considerations which are taken into account when it is proposed to build any other manufacturing establishment of some importance, and any error which is committed in this respect, as well as in the general arrangement of the necessary buildings and apparatus, will subsequently prove to be a constant drain upon the resources of the works.

The first principle which should always be kept in view is, to so locate the works as to secure the greatest economy in receiving the materials which it is proposed to use in the manufacturing operations, as well as those which are required in constructing the establishment; the first of these two conditions, however, is the most important, being one which forms the largest item in the running expenses of the works, and one which is always present; in most cases, therefore, the first would determine the exact location of the works.

The nature, too, of the site is a matter of great importance. In all engineering structures of this class the kind of soil upon which it is intended to build plays a most important part; and this is particularly true of the case of a gas works where the buildings and other structures are usually quite numerous. That locality, then, is to be preferred which, without sacrificing to any great extent the good qualities already referred to above, has the advantage of offering fewest difficulties, and therefore causing least expense, in constructing the foundations for the buildings and the gasholder tanks.

It often occurs that, in otherwise fortunate localities, the difficulties which have just been referred to, and which are too well known to require enumeration, are quite sufficient to warrant the selection of a site less favorable in other respects.

But even these—important as they undoubtedly are—are second only in importance to the first principle which was stated above, and not unfrequently have very successful works been built in localities which were as unfavorable for building purposes as they could possibly be.

It was thought necessary at one time, in order to successfully carry on a gas works, to locate it at the very lowest part of the town. The only advantage of any importance lies in the fact that in a low site the pressure which is necessary to drive the gas through the mains, and the resulting leakage is less than in works situated on a higher level than the town itself; but even this advantage becomes rather insignificant when the fact is borne in mind that a difference in level of 10 feet affects the pressure to the extent of but one-tenth of an inch of water. The advantages secured in this manner are not, therefore, usually sufficiently great to justify the purchase of a low site, when a higher one can be procured at a smaller cost.

In regard to the character of the town as determining the location of the works, a few words will suffice. If it is a manufacturing town in which most of the mills, shops, etc., are in close proximity, or if, for any reason, the consumption of gas in one part of the town is much greater than in other districts, or, finally, if the town appears to be growing in a certain direction, it would appear advantageous, and it no doubt really is, to locate the gas works as near that district as may be—provided, however, that such a course does not seriously interfere with the proper fulfilment of other and more important conditions.

The general principle, however, which would usually be followed is—"that the site should be selected rather for the facilities it affords for receiving and delivering material by rail and water, than for the supposed advantage of a low level as bearing on the distribution of the gas."

On the other hand, it is a matter of very great importance, in erecting new gas works, that the amount of capital be reduced to a minimum. The capacity of the plant, it is true, should be fully equal to the maximum daily consumption in mid-winter; but it must not be forgotten that this demand generally exists for not more than eight or ten days in the year, while in midsummer the quantity of gas sent out is but from 30 to 50 per cent. of the maximum; it is obvious, therefore, that a large amount of capital must be sunk which lies dead for more than half the year.

We have dwelt at some length upon the above conditions, all of which arise when a gas works is projected; the subject is one of such importance, however, that our course will be considered justifiable.

The site for the projected works.

Bearing these principles in mind, it is assumed that the real estate necessary for the works cannot, in the first place, be secured at or near the lowest level at a reasonable price although, as regards facility of distribution, it would be preferable to all others; then, too, its advantages in receiving material are not sufficiently great being, as already stated, at some distance from the water.

The same objections, essentially, may be advanced against the highest parts of the town; the railway, it is true, runs within a quarter of a mile of this locality; but transportation by rail, though more reliable than by water at certain seasons of the year, is, as a rule, much more expensive. In addition to these objections may be mentioned those inherent to a high level, viz.—increase of pressure at the works, and consequently an increase in the percentage of leakage.

It is finally assumed that the most eligible site for the projected works is at a point 10 to 11 feet above the lowest level, and from five to six feet above the surface of the water; transportation facilities are afforded by the canal or river, while the soil in this locality is of a kind which would not offer any special difficulties for building purposes.

Thus located, the works are in the outskirts of the city and in the manufacturing district; it is probable, therefore, that under average careful management they will not prove to be a nuisance to the community at large.

[To be continued.]

* A Graduating Thesis at the Stevens Institute of Technology.

British Association of Gas Managers.

TUESDAY, July 25.

[From London "Journal of Gas-Lighting."]

VARIOUS METHODS OF JOINTING MAINS, WITH A VIEW TO THE REDUCTION OF LEAKAGE.—LAYING AND CONNECTING SERVICES.

These titles in the annual list, "suggestive of subjects to be treated upon," appear to be so closely connected that they should be covered by one paper. As the titles are rather wide, "Jointing Mains," "Laying and Connecting Services," I will deal with them in the same spirit, gleaning in other fields than those in which we are accustomed to labor. Waterworks may thus yield us the fruits of their wider and greater experience—an experience exceedingly interesting from its varied practice and great antiquity.

Anterior to the magnificent aqueducts of the Romans, we find in the remains of the structures of Solomon, around which such a halo of poetic beauty shines, a perfect water conduit. The water runs, it is said, into Solomon's pools "through round earthen pipes, about 10 inches in diameter, which are cased in two stones, hewn out to fit them, and they are covered over with rough stones, well cemented together, the whole being sunk in the ground." Ages afterwards stone water ways were laid down in Manchester, by the celebrated Rennie, but lacking the knowledge or precautions of the ancients—lining them with "earthen pipes," and covering them with "rough stones well cemented together"—the employment of them was attended with most disastrous results to the company, and resulted in the works being transferred, in 1817, to another company.

Palladius, in his treatise, "De Re Rustica," teaches how to find springs, and to conduct the water to farm or villa by a channel constructed of masonry, or by means of pipes of lead, of wood, or even of earthenware; but he testifies his aversion to the use of lead, as apt to become poisonous. Still it may be inferred, by the allusions from the poets, that such pipes had come into very common use. They were not cast tabular, but consisted of thin plates, bent up into the form of a cylinder, and soldered along the edge. The smallest of the pipes employed in distributing the water from the reservoir, or *castellum*, was called a *denaria*, being 10 feet in length (about the length of a modern pipe), the sixteenth part of this in breadth, and weighing 120 Roman pounds, which gives a thickness exactly of a quarter of an English inch. Stow gives the earliest intimation of any attempt being made to supply London with water by means of leaden pipes, "The watercourse being from Paddington to the Cross, in Cheape, which was begun to be builed in the year 1235, but was not com pleted till 1285." It may be interesting to know "this grant was confirmed by Henry VI., and likewise a writ of Privy Seal issued, allowing the Lord Mayor and citizens power to purchase 200 fodder (loads or tuns) of lead for the intended pipes or conduits; and also to impress plumbers, laborers, &c., for carrying on the said work, provided always that their wages be punctually paid them." To this may be added another interesting fact, quoted by the author of the work from which this is taken—"Hydraulia." It is that "the pipes in those times were not, in some instances, imbedded in the earth, as is the present custom, but inclosed within a capacious arch of brickwork, into which workman could upon occasion descend to repair any decay or accident."

"In 1610 a Mr. Thomas Hayes, an English gentleman, constructed a conduit, without the gate at Aldersgate, to which the water was conveyed from the Thames in pipes of wood and stone."

Stow's "Survey of London," republished 1633, contains the following:—"There is not a street in London but one or other of these waters runs through it in pipes conveyed underground; and from these pipes there is scarce a house, whose rent is £15 or £20 a year, but hath the convenience of water brought into it by small leaden pipes, laid into the great ones" Matthew's "Hydraulia," 1835, gives a considerable amount of interesting information upon the early history of water supply. "At the commencement of their respective operations for supplying the Metropolis," this writer says, "both the London Bridge and New River Works conveyed the water through the different streets by means of wooden pipes, to which leaden pipes of smaller diameter were attached for conveying it into the house. The wooden pipes, being generally made of elm, which is a soft and porous kind of timber, occasioned many inconveniences, either from fractures or decay; hence they proved a source of constant trouble and expense, from a great part of them requiring to be changed every two, three, or four years * * * * moreover, the nature of the materials, as well as their limited magnitude, necessarily confined the bore of wooden pipes to a comparatively small size, varying from three to six or seven, and a few near the reservoirs might be ten or twelve inches, consequently in order to afford a supply of water to places at a considerable distance from the reservoirs, the use of several lines of such pipes was generally required. In 1810 nine trains were laid side by side along one street * * * * The quantity of water lost by fractures, &c, was estimated at about one-fourth of the whole that entered them from the reservoirs. * * * * For nearly two centuries was this insufficient plan pursued. Whatever may have been proximate cause of generally substituting pipes of iron for those of wood, the advantage of the change were strikingly important. Certainly, in some cases, they had previously been employed for conveying water to a very limited extent; but the operations of gas lighting rendering them indispensable, its extensive introduction probably suggested the general adoption of their use as conduits for water * * * * Although previous to the year 1810 the New River Company had placed in the earth wooden pipes several hundreds of miles in length, yet during that period and 1820 the whole were taken up, and iron substituted through the entire range of their district. The expense of this alterations amounted to nearly £300,000* * * * When first adopted, it was the practice to make a flanche at each end for the purpose of connecting them together by screw-bolts and nuts; however, a little experience demonstrated the inconvenience of this mode of construction them, for the expansion and contraction by the variations of temperature occasioned their jointings to become loose and leaky, or the breaking of the pipes. The various injurious effects and disadvantages proceeding from this chase, led to an alteration in their form, which proved an effectual preventive of any defects from the action of heat and cold on the metal. This important improvement consisted in forming one end of each pipe larger than than the other with a kind of socket, severel inches in length, into which the narrow end of the corresponding pipe could be inserted, and the space remaining between them closely filled up with hemp, wadding, and lead, so as to render the joint perfectly water tight. By adopting this method of connecting the pipes, the changes of temperature have not the effect of breaking them, though occasionally their jointings become imperfect, and require a little repairing to prevent the escape of water. This improvement is ascribed to Mr. Thomas Simpson, formerly engineer to the Chelsea Water Company* * * * The New River Company's premises were at the bottom of Dorset Street, Salisbury Square where they had a spacious wharf for landing timber, shops for boring pipes, &c. This site was that on which the City Gas-Works were subsequently erected."

I have been fortunate enough to meet with a sketch of the machinery employed in boring these wooden pipes, and deem it of sufficient interest to place it before you. I found in the "Dictionary of Arts and Sciences," 1807, Dr. Gregory, says: "wooden pipes are trees bored with large augers of different sizes, begining with a less and then proceeding with a larger successively. They are fitted into the extremities of each other, and sold by the foot."

To condense the foregoing for our own use, we find then—

First.—That the length of a lead pipe used by the Romans was about that of our own cast-iron ones.

Second.—That subways in England are more than an old idea; it was carried into practice centuries since, and doubtless, from its being abandoned, was found impracticable, even for water-pipes.

Thirdly.—That the practice of water engineers, in the laying of iron pipes, was of little service to the pioneers of gas lighting, but rather the "extensive introduction" of these pipes, according to Matthews, "probably suggested the general adoption of their use as conduits for water," but

Fourthly.—If flanched pipes only were employed by gas engineers in 1810, we are indebted to an older art for a valuable improvement in canalization.

Lastly.—The experience of the water engineers, which led to the invention of the spigot and faucet, should not be lost upon us; that a system (to put this matter in the most general and least objectionable form) of canalization, as in the human body, should be elastic.

With the rigid system, which was the "turned and bored" wooden pipes, the loss of water was "one-fourth;" with the flanched iron pipes "a little experience demonstrated the inconvenience of this mode of constructing them, for the expansion and contraction by the variations of temperature occasioned their jointings to become loose and leaky, or the breaking of the pipes." The length of each pipe, too, was inconsiderable, which was of great advantage to the system. Dr. Gregory says, "they are cast in forges," and "their usual length is about 2¼ feet; several of these are commonly fastened together by means of four screws at each end, with leather or old hat between them to stop the water." Barlow and Babbage, "Encyclopædia of Arts and Manufactures,' 1848, bear upon this point: "Commonly now," they say, "the iron-pipes are inserted one within the other, like the old wood pipes, for experience taught engineers that a long and continuous pipe, securely screwed together, exceeding about 300 feet in length, would pull itself to pieces, by the contraction of the iron. from the change of temperature between summer and winter."

I have endeavored to find the exact date of the invention of the spigot and faucet; but have been unsuccessful. In 1758 a patent was granted for "casting tubular and other metallic articles—guns or cannon, fire-engines, cylinders, pipes, and sugar-rolls;" guns or cannon, however, "according to the antiquarian Lower, Dr. Percy states, were manufactured at Buckstead, in Sussex, by Ralph Hoge Hogge, in 1543." To William Bell, in 1808, a patent was granted "enclosing in pipes or cases of iron or of wood, pipes or tubes of porcelain pottery." These porcelain tubes are designed for the conveyance of water in preference to wood, which, the inventor states, "is liable to decay and become rotten, generating insects and noxious animalculæ; and that pipes of metal, without the lining of a porcelain pipe, corrode and impregnate the water, rendering it unwholesome and poisonous, and unfit for domestic purposes. Each tube is made with a socket at one end, to receive the plain end of another, leakage being prevented by the introduction of cement." This, then, may fix the date of the formation of the socket; and the joint, the yarn and lead, the true joint, perhaps, was the invention of Mr. Simpson, about this time, or between the years 1808 and 1810. Clegg is entirely devoid of information upon our subject; and Mr. Murdoch's paper, read before the Royal Society in 1805, is most tantalizing. The latter says the gas "is conveyed by iron pipes into large reservoirs, or gasometers," and thence "conveyed through other pipes, called mains." Matthews, however, tells us that "the first street mains laid down in Pall Mall (1807) were lead pipes;" also, "The pipes which Mr. Winsor employed to convey the gas from his apparatus consisting chiefly of lead, and only those parts which connected them with the burners were copper." The same author gives a sheet of drawing of various kinds of "pipes, &c., employed in water-works," selections

from which I place before you; also from Accum and Peckstone. It will be observed that the principle of the joint is the same in all, but very different in one point from that shown in Clegg, which is the ordinary socket joint now in general use. The point to which I refer is the absence of a bead on the spigots of pipes in early use. This is essential to the principle upon which the joint was constructed—that it should be elastic, capable of contracting and expanding. Without a bead the joint is a rough gland, each pipe being free, as far as the rough surface will permit, to move in another. With the bead, looking at the joint as a gland, it is theoretically imperfect, and we know in practice that the joint "draws"—lead and packing being drawn from the socket, instead of the spigot moving through, the same as, I believe, was originally intended; though doubtless the roughness of the spigot, and the clip of the lead upon it, would materially affect the practice of what is theoretically correct. This idea of flexibility, too, would be strengthened, if not suggested, at this time (1810) by the practice of James Watt, who constructed a 15-inch flexible water-main across the Clyde, the flexibility being obtained from ball and socket joints; a sketch of this is placed before you. From that time up to the present many schemes have been devised and patented with this object in view: drawings of the most interesting of which will be found hanging on the wall.

The important and very serious subject—leakage from main or pipes—is then, not a matter to which our attention alone has been directed. I have already stated that the loss with the wooden pipes was 25 per cent. From a paper on "Leakages in Pipes," by Mr. Whitney, Cambridge, U. S., read before the American Society of Civil Engineers in 1873, this matter, it appears, is not less serious now than it was a hundred years ago. The writer says: "The result of his experiments was the discovery of no fewer than 200 leaks of from 1000 to 2000 gallons an hour each. The necessary repairs were made, and thereby the average daily consumption was reduced from 85 to 35 gallons a head." At the very commencement of gas lighting, the subject attracted attention. Sir William Cosgrove, in one of his reports to a committee of the House of Commons, 1823, recommends "laying all main pipes in clay, in order to prevent the escape of gas." Before this committee, a Mr. Samuel Lay gave evidence upon this subject; "and his great practice, it is said, with the water company, and then as outdoor superintendent to the Chartered Company, had made him familiar with the effects which had occasionally resulted from the leakage of gas from fractures and imperfections in the mains or small pipes." Our own Association has well discussed this subject, and I do not hesitate to say that in no one matter have we rendered more valuable service to each other and to the undertakings with which we are connected, than in the consideration of this important question, and this Association may well be proud of the benefits it has thus indirectly conferred upon the public. Our Transactions are full of information from the large and varied experience of our most eminent men, and any one, to use the words of a past president, Mr. Edward White, "who looks back through the volumes of our Transactions, will see how worthily the objects for which the Association was called into existence have been carried out." Though agreed upon the one important question—the serious loss from leakage—there is, in the matter of jointing pipes, a diversity of opinion.

Mr. Hawksley, who has so ably presided at our meetings on several occasions, has given us the benefit of his large and varied experience. In closing the discussion on Mr. Cathel's paper on "Leakages from Gas-Mains and Service-Pipes," read at Nottingham in 1867, Mr. Hawksley says: "According to his opinion it did not matter much whether they had the best form of turned and bored joints, or whether they had lead joints well made. * * * It was not worth a consideration in the first instance, but with reference to the question of how far these joints became deteriorated by the many accidents to which mains were exposed in the street * * * he certainly, as the result of experience, rather preferred well-made lead joints. They were more elastic." He thus gives us the reason for holding his opinion, and these views are in accordance with the theory and practice of engineers at the beginning of the present century; and the theory upon which this practice rested, doubtless came, as I have attempted to show, from their experience of the unsuitability of such a rigid and inelastic system of mains as they employed in using a flanched joint. Yet so thoroughly is this inelastic system carried out in Manchester that "where they could not make use of turned and bored joints," the late Mr. Rafferty said "they made their joints with iron borings;" and "the pipes almost formed." he said on another occasion, "one substance as to closeness," and "expand and contract at the same time;" but how these two conditions could be reconciled he did not attempt to show.

These two systems, the rigid and the elastic, I would make the representatives of two classes, under which all descriptions of joints might be fairly placed, and attempt to take the matter beyond the changing province of opinion and variable individual experience, and place it upon the firm basis of mechanical principles.

One of the prettiest ideas, perhaps, but quite impracticable, is that of a Mr. Williams, of Liverpool, patented in 1869. I say one of the prettiest; I may also add an exceedingly useful one to illustrate, as a working diagram, the practical essentials of a conduit or gas-main. The joint consists of "a perfect spherical zone of an external diameter duly proportioned to the internal diameter of a cylindrical socket, the two services being well and truly fitted to each other, so as to be tight, and having perfect contact by external pressure solely in one circular line or ring of points around the zone. The joint is therefore a movable one, and in change of level or direction of subsidence or disturbance the pipe line is self-adjusting, and distortion is unattended by leakage or fracture." Theoreticaliy, then, we have here a perfect flexible metalic main, and its description may be taken as the description of the principles upon which a conduit or main should be constructed, "self-adjusting, unattended by leakage and not liable to fracture," or subject, we may also add, to greater deterioration in the joint than in the pipe.

Now let us examine, first the change of condition to which a main is liable, and then the common joints as usually employed—the flange, spigot and socket, and turned and bored—and see how far mains thus jointed are capable of adapting themselves to disturbing causes. The greatest disturbance arises unquestionably from the soil itself, either from subsidence under, or pressure from above the pipe, or from contraction or expansion in the pipe themselves. To simplify the question, we will assume that subsidence, as it is doubtless the most obvious, is the only cause of disturbance. We will assume, also, if you please, that a main under examination was laid horizontally. Now, as a straight line is the shortest distance between any two given points, it is self-evident that if a main between those two points sinks with the ground from subsidence of the soil, it will assume the form of an arc of a circle, and hence must become elongated. The effect, too, will be produced, it may be added, from any disturbing cause but contraction. The main, therefore, to remain sound under these conditions, must be self-adjusting, with an axial freedom (capable of moving around the original common axis of the main), and possessing power of elongation. We here see, at once, in examining the common joints, that the flange is under these conditions useless; it has no axial freedom and no power of elongation, but that arising from expansion of each individual pipe, and this power we have excluded in considering the question. The turned and bored we must reject too from the same cause, having no power of elongation, unless some of the joints open as conical valves. The application of the same principles to the consideration of the socket and spigot demonstrates the greater suitability of the joint for the purpose intended, especially without a bead, giving, as it does, a greater amount of axial freedom and elongation than those at present in use, therefore less liable to fracture or become unsound from disturbing causes. No other form of joint alone will give this freedom. I show diagrams of both a stuffing-box joint and a ball and socket joint (patented). The stuffing-box joint gives longitudinal freedom, but no axial liberty; the ball and socket joint gives the latter, however, but has no power of elongation. Thus we see how beautifully simple is the socket and spigot principle, combining in itself two distinct mechanical actions.

I will not attempt to lay before you the various contrivances for jointing pipes, you may judge of such a task from the fact that up to 1866 nearly 120 patents had been granted for improvements in the same. Most of these are quite unfitted for the purpose for which they were designed, while in others there is to be found such an amount of ingenuity and familiarity with the practical requirements of the work, that they may be studied with advantage by those desirous of pursuing the subject. India-rubber enters, however, very largely into most of the schemes as washers and packing. Collars or thimbles, whole or in sections, with packing of lead or india rubber, have also been in great favor with inventors.

The same object as Mr. Williams had in view has been attempted another way, by Mr. Gayet, in 1857, putting a plain spigot through a flat washer of india-rubber placed in a recessed flange, and secured by a plate of metal. This, however, is but little more than another form of Dr, Normandy's joint; it has, however, the advantage that all sockets have over thimble or collar joints—there is but one joint to connect two socket pipes, instead of two for a collar. Mr. Homersham, 1869, also combined the principle of a zone with a conical socket.

I have now to draw your attention to my own patented joint. It is a turned cylindrical spigot, with a common socket, indented, grooved, or plain. Over the spigot is placed a flanged sleeve or sheath of thin sheet lead; the flange is placed at the bottom of the socket, and around it a packing of white spun-yarn, then the lead, and thus far the joint is made in the usual way; but on the top and in the middle of the socket a hole is drilled, into which is poured some melted tallow mixed with oil, which, running into the joint amongst the yarn will act as a lubricant to what will then become a glandular joint, and also prevent any escape from the joint if the lead becomes disturbed. Instead of pouring in the tallow, a greased yarn may be caulked in. The thin lead sleeve answers three purposes; first, to keep the loose spigot in a true position in the socket while making the point; second, it prevents the yarn getting through the joint, as I have found it do, into the pipes; third, it allows both a longitudinal and an axial self-adjustment; the thin lead with the elastic packing yielding to the extreme end of the spigot, without disturbing the joint, relieves the socket of the pressure that would otherwise be thrown upon it by disturbance of the ground, the bore being kept clear, too, from the internal taper given to the pipes. It will be seen that the elements of this joint are the same as those that have been long in use, and, therefore, there is no new or untried principle; a new arrangement only to obtain, without complication, a more elastic joint. The cost of the joint is but little more than the common joint, and against this may be placed the saving that will be effected in material and labor in taking up and relaying these pipes, by drawing them out, instead of cutting and breaking the spigot as with the common socket pipe. If compared with the turned and bored pipe, against the cost of the lead joint may be placed the saving of boring the socket, and then the pipes are perfectly elastic and gas-tight when jointed, instead of being a range of tubular valves strung together, for such is the common turned and bored pipe. No movement can take place in these, whether by settlement or contraction, without one or more of these valves opening and permitting the gas to escape. What the escape from mains is may be judged of by studying the table on the wall. So much has been

said vaguely upon the subject of leakage from mains and services, and such opposite views have been given expression to in our discussions upon the subject, that I will for a moment return to it, to draw your attention to the tabulated report of the examination of upwards of 28,000 yards of mains. Of this quantity 26·29 per cent. was sound; the leakage on the remainder and services was 1294 feet per hour; or 5 580 feet per hour per 100 yards of main, and there were 13 broken pipes, 194 bad joints, 15 leaky plugs and caps, 137 services, and 10 escapes from other causes. Well may Mr. Jabez Church have said that we "could not dismiss from our minds the conviction that with every consideration, and most careful inspection, there was an enormous amount of waste from the mains and services."

For the repairing of broken mains I employ a segumental thimble or collar, tne two halves of which are arranged, so that on being placed together over the main, they may be made to slide into each and wedge themselves together around the pipe, a piece of sheet lead first being placed over the fracture, the joint then being made in the usual way. Thus a permanent joint may be made in the time of a temporary one, and the loss of gas and time and material in cutting out a broken pipe to insert the ordinary collar is thus saved, and the joint made without the employmont of clips with nuts and bolts.

The value of these segumental collars, however useful for the purpose, is much greater for the purpose for which they were designed—to strengthen small mains at the points of junction with the services. It is no unusual thing for an inch service to be inserted into a 2-inch main, and this means cutting nearly one half of the main through to get the 1½ inch hole necessary fer the 1-inch service. No wonder that we find some of our worst leaks at such places. You will see, by referring to the tabulated report, that we found no less than eight broken pipes on 7383 yards of 2-inch, but not one broken on 6107 yards of three-inch, and so with the next size larger; in putting a 2-inch service into a 3-inch main, it is considerably weakened by the 2½ inch hole that must be made. This is not the only evil either, the bore of the main is considerably lessened by the insertion of the service-pipe, and thus the flow materially affected. Now a remedy for this will be found in the employment of this segumental clip, in the form of a T-piece—the joint will be strengthened and the bore kept clear by attaching the service to a socket on the clip, drilling the hole after the clip joint is made, and then screwing the service-pipe into the already tapped socket. Or I would, in the case of very long services, prefer an expansion joint, made on the principle shown for mains. Doubtless the same care in this respect is as necessary in laying services as mains; indeed, I might almost say more so, as they must frequently be laid near to the surface across open areas, thus being exposed to every change of temperature.

Unfortunately little or no heed is paid to the contraction and expansion which must ultimately affect the joints. We came across such a case a short time since, the service being pulled apart in two places. On 352 feet of pipe (102 feet 2-inch and 250 ft. ¾ inch) there was a loss of 30 feet per hour, 3 inches pressure' the pipes having been broken in two places. You will here remember the quotation from Babbage and Barlow, "that a long and continuous pipe, securely screwed together, exceeding about 300 feet in length, would pull itself to pieces by the contracting of the iron." Both, then, for the sake of the main as for the service, this should be free to adapt itself to disturbing causes, its junction with the main, too, should strengthen it and in no way affect the bore. The other end of the service also should be well cared for. The cock has been almost entirely neglected, both in its construction and use—¾-inch cocks in many cases not having ½-inch gas ways, and the plugs never methodically taken out or cleaned or greased, though there are frequent reports of leakage from them. On examining the complaint-book, I find about 6 per cent of the total number of complaints are from this cause.

I have but one other matter to draw your attentson to, in connection with services—their protection from deteriorating influences; whether lead or iron, both equally need this—this you will see from samples laid before you—lead pipes, from the action of some soils and from the lime, being built into the walls of houses; the iron pipes from the soil likewise. The protecting covering, whatever it may be, should be as the pipes themselves, elastic. I will not enter into the questson of the relative advantages of lead and iron services. The latter, well protected with tar and sawdust, umst be as durable as lead, and cannot be injured—as may be seen by specimens on the table—by picks and tools of other workmen.

I know of no covering to equal what I have now used for some years, tar and sawdust. I have placed a piece of service-pipe on the table, that has been in the ground seven years, and it is as good as ths day it was laid. By its side is placed a piece entirely eaten through, in use only a short time longer. The plan hitherto adopted has been to imbed the pipes in a trough of this mixture, but now I find it is better to entirely encase the services, so that in case of disturbance of the ground, the mixture is kept in contact with the pipes, and this I do in a very simple way, by an adaptation of the segmental clip; this arrangement shown by diagram may also be applied to other than service-pipes when laid in bad soils.

The market place of South Shields is laid out for about 400 stalls, these are lit by portable stand-pipes, the connexions of which are ordinary union joints. With such, as may be supposed, the loss of gas is enormous; and besides this, the stand-pipes are frequently removed without turning off the gas. To remedy this, I have devised the following plan: Into a small metal box, connected with the service, is screwed a fixed cock plug, over which works the barrel, the outside of which is square. Around the cock thus formed, and at the bottom of the box, is an india-rubber washer; on the under part of the top of the box are two inclines around a circular hole with two grooves; corresponding with those are two feathers on a socket attached to the stand-pipe. By passing the feathered and socketed end of the stand-pipe into the box, and turning it round, the end of the socket will be pressed by the ends of the feathers, passing under the inclined pieces on the under side of the box on to the washer, and form a gas-light joint, the gas at the same time being turned on. Before the pipe can be removed, it is evident the action must be reversed, and so the turning on of the gas is ensured. Not only for such places but for all purposes where temporary connexions are required, such stand-pipes and connexions will be useful, but especially for taking pressures, which should be done through every district periodically. It will be remembered that in the evidence taken before the select committee on the Metropolitan Gas Companies Bill (1875) that this matter occupies a prominent position towards the end of the report, both Mr. Keates and Mr. Pole being examined upon the point as to the practicability of complying with the eighth clause, taking the pressure "at the main near the junction therewith of every customer's service-pipe." With this arrangement, it is obvious that the pressure could be most readily and satisfactorily taken.

I have but one other matter to place before you before leaving my subject. In my paper of 1873, on the "Distribution of Gas," the following occurs: "Indeed, with the great loss sustained by some companies, it may be almost a question for consideration whether it would not be advisable, as it was in the case of pressure, to have a separate instrument for each district, rather than one common to the whole, to have a meter or meters as well as a governor upon each main." I explained my arrangement for carrying this out in a modified form—a fixed meter in the governor room, with a system of valves for testing each district through the summer nights. But I would extend this principle still further, subdivlding each district, and placing upon it a fixed meter and hydraulic valve. On the normal consumption then being ascertained, the closing of the valve or valves would bypass the gas through the meter, and give, by a short observation, a very reliable test of the portion cut off. In districts with shifting soil, this arrangement will be the means of saving a considerable quantity of gas; by periodical testing any considerable leakage would at once be indicated. The arrangement too, is useful in laying and testing mains, the connexion being so readily made and broken for the testing without the trouble of shifting the meter, etc. Models of this, with the joint and clip, will be found on the table. To all such valves I would attach the service-pipe of the nearest lamp, glazing the top with red glass, and fixing the end of the service in a position to be sealed before the mains were affected by neglect of the valve; all syphons, too, could have this danger-signal readily applied, and thus an effectual guard be employed against neglect or accident.

Such precautions as these, and what I have laid before you, cannot be too strongly insisted upon, as the economy in distribution dependent upon them. I would not elaborate or complicate dissribution; but the exigencies of the work are such, and so vitally affect the interests of our undertakings, that every practical safeguard should be impressed into the service. Durability and adaptability should be our two watchwords—durability of the mains and services, durability of the joints; the adaptability of both to the changes of condition to which they are subjected, Upon the consideration and observance of these watchwords economy is dependent, not upon the nominal cheapness of the first cost of the plant, and on the more or less conscientious observance of them, so a greater or less degree of economy will be effected.

Large Pipe-Founding Contract.

A contract for 80,000 tons of cast-iron pipes, to be delivered at Rio de Janeiro, has been negotiated by Messrs. R. Laidlaw and Son, gas and water engineers and pipe-founders, Glasgow, but the undertaking was found to be of such an extraordinary extent as to make it very desirable, if not even imperative, to enlist the co-operation of two other pipe-founding firms, those of Messrs. Thomas Edington and Sons (Phœnix Foundry) and Messrs. D. Y. Stewart and Co., who have for several years been jointly engaged in a number of large waterworks contracts; and now, for the first time in the history of pipe-founding, there are to be three eminent firms leagued together in the execution of a single contract.

The undertaking of introducing into the city of Rio de Janeiro an abundant supply of water has been taken in hand by the Government of Brazil, the chief contracter being Signor Gabrielli, who, though an Italian, is a naturalized British subject, and is a gentleman who has had great experience as a contractor—three of his undertakings being the Vienna Waterworks, and the new dock works at Malta and Chatham. It is understood that the execution of the entire contract, which has been entrusted to Mr. Gabrielli, will cost something like £1,700,000, and that the money will be raised exclusively by Brazil out of her ordinary resources, and without having recourse to the London money market.

We understand that the piping now contracted for is intended exclusively for the conduits—of which there are to be two—leading from the reservoir or source of supply to the city of of Rio de Janeiro, the area of distribution within the city being already most efficiently and completely laid with service mains. On that account the pipe contract under notice is chiefly for mains of large size, 31¼ inches in diameter, the smaller sizes forming only about 10 per cent. of the whole. It is intended to commence delivery of the pipes within the next two or three months, and continue the delivery in regular quantities over a period of two and a half years from the time of closing the contract.—*Iron.*

Remarkable Artesian Well.—At Prairie du Chien, Wis., an artesian well daily discharges 809,616 gallons of water. The well is only 960 feet deep, but has head enough to raise the weter 900 feet above the ground.—*Scientific American.*

Correspondence

[Correspondents, in all cases, should sign their communications with their names and address in full—not for publication, unless desired, but as a guarantee of good faith.—Ed.

Knoxville, Tenn., August 22d, 1876.

Mr. Editor: Your leading article in the last issue of the Journal, upon the "Progress in the Science of Gas Making," reflects rather severely on us gas makers.

I am aware that all due allowance should be made to an editor who has to write upon such a glowing subject as gas, when the thermometer points to 90° in the shade.

No doubt it would have been more agreeable and refreshing, at least I think you would have taken a more cheerful view of things if your article had been upon the progress in the science of *ice* making; and yet, after taking all these trying circumstances into consideration, I cannot admit we deserve, or that you are justified, in making the following statement. You say:

"The present excessive cost of manufacture is a brain difficulty, or a difficulty resulting in a long disuse of the brain faculties. The rule of thumb has had too full a sway."

Is this charge true? I contend, on the contrary, that we conduct our works and manufacture our gas on as correct scientific principles as are at present known.

Moreover, I believe we succeed in getting as much gas from a ton of coal as they do in England. In that country, as you truly observe, "some of the first minds of the kingdom are enlisted in the service of the gas makers." And what, may I ask, have these great minds accomplished in the science of gas-making there that we do not also have in practice here? or in what particular detail in the art of gas manufacture and distribution are the English ahead of us?

I freely admit a fact which is of the utmost importance, that they sell gas much cheaper than we do; not because they have a more economical method than we have, but because the price of labor and material is such that they are enabled to manufacture most articles cheaper than we can. They have also the advantage of us in a ready sale of their "residuals," in this country it is not so.

Much of our residuals are wasted; but it is not our fault—we cannot compel a market. Who would rejoice more than we if our residuals had a ready sale?

I agree with you that it is our duty to seek out, and put in force, every improvement that has for its object the production of cheaper gas. But I say this without fear of contradiction—that the gas companies have spent, and do spend, more money in trying new inventions, in adopting so called improvements that have for their object the lessening of the cost of the manufacture and distribution of gas, than any other industry has spent for the cheapening of their product whatever it may be.

Every experienced gas engineer has been long cognizant of the fact that by our present method of manufacture we failed to get all the gas out of the coal. Two of your correspondents have lately been demonstrating this fact to us in an elaborate manner. I wish much they could have gone a step further and pointed out to us a practical remedy. The patent office will show that this subject has received the utmost attention, but as yet without any practical success; however, it is gratifying to know that gas engineers in this and other countries are still endeavoring to overcome this difficulty.

Let us hope that their efforts will be speedilly successfully. Yours respectfully.

Jas. Somerville

Is Cement a Corrosive?

Mr. Editor: In your last issue it is stated, in the column devoted to chemical and scientific items, in relation to the recent gas explosion in the Capitol at Washington—"that the iron pipes embedded in cement were mere cylinders of rust, so completely were they honeycombed by the corrosive effects of the cement."

Can this be true, *i. e.*, that the pipes were honeycombed by the corrosive effects of the cement?"

"The natural hydraulic cements of this country are made from argillo-magnesium limestones, the principal ingredients of the stones being the carbonate of lime, carbonate of magnesia, and clay."

The elements which give the cement the power of setting, or crystalizing under water, being the silicate of lime and alumina, and magnesia, the double silicate of lime and alumina, and the aluminate of lime. I would ask where are the elements necessary to oxidize or corrode iron? Are not the elements present, with the exception of the oxygen in the water, and that is combined so that it is harmless, the ones to preserve and not corrode?

Is it not true that cement is a preserver of iron wherever the iron is sufficiently covered with the same?

I cannot lay my hands upon the evidence at this momont, but I remember that the cables of the Niagara suspension bridge, built in 1855, were examined in 1875, to see if they were defective after their service of 20 years. The cables, at the anchorage, were embedded in cement, and were found to be, when uncovered, as perfect as when the wires left the mill.

It has been the custom for years, to coat the bottoms of iron steam ships, internally, with Portland cement, in order to prevent oxidation by bilge water.

I have specimens of wrought iron water pipes, coated with cement, that have been for more than sixteen years, in soil very apt to oxidize wrought iron. The surface of these pipes, where the cement has been removed for examination, is as clean and perfect as that of a new pipe, and the quality of the metal, shown in cutting the specimen, seems excellent.

The evidence of the preserving effect of cement was so strong, that we began some time ago to embed all of our service pipes, when laying them, in Portland cement. We have thought that by so doing, we were rendering them practically indestructible. But if cement is a corrodent we want to know it, as we desire to keep our leakage account as low as possible. If, Mr. Editor, you can get the evidence of this, and will publish the same, you will confer a great service upon every one interested in the use of iron, and will surely receive the thanks of X.

The Amount of Light Obtained from Coal.

Louisville, Ky., August 15, 1876.

Mr. Editor: I have read with much interest an article in your paper of June 16, and with your permission I propose calling attention to some important facts suggested by Mr. Farmer, in his review of the experiments made by Mr. Lamson, at the Boston Gas Works. These deductions certainly prove that a much larger amount of light may be obtained from coal than is generally extracted.

Mr. Farmer, quoting from Dr. Gesnor's work on coal and petroleum says:

"That one ton of Pittsburgh coal will prodnce forty-nine gallons of crude oil and also a considerable quantity of rich gas, * * * * Now, as it is generally agreed that one gallon of crude oil will produce seventy cubic feet of seventy candle gas, we certainly ought to get better results than we generally do, it is very singular that with the ordinary process for making gas from coal, we never obtain any rich gas whether the yield be large or small. We never see any signs of such rich gas as that given in the preceding calculations, consequently I am certain that the present system is radically wrong."

I fully agree with Mr. Farmer, in the opinion that the common process must be defective, for by it the best results yet attained only convert about sixty per cent. of the volatile matter taken out of the coal, into permanent gas, and that of a much lower illuminating quality than might reasonably be expected, for on examination of the tar cistern, we find there from twelve to thirteen gallons of tar for each ton of coal carbonized, composed of just the elements necessary to furnish gas of a very high illuminating quality, and yet so combined, that all attempts to convert them into illuminating gas have been unsatisfactory, if not total failures. Now, sir, in my opinion, where we begin to produce, fixed coal tar is just the point at which the present system departs from the correct one. And it is with a view of calling attention to this point that I am induced to say what follows, for I confidently look forward, and that in the near future, when we shall produce more and better gas from a given quantity of coal. Now, as the temperature determines the quality, quantity, and character of the product, I may be excused for repeating here what every engineer and superintendent already knows, namely, that at a red heat just visible in a dark room (980°) much heat is evolved, and a considerable quantity of rich gas, at a cherry-red heat (1500°) highly illuminating gas is produced, and at a full red or low white heat (1800° to 1900°) gas of a poorer quality for lighting purposes is given off. Now, as the intensity of decomposition is in proportion to that of the heat, is it not reasonable to conclude that there is a temperature at which in the process of decomposition, olefiant gas and volatile hydrocarbons should be formed, and yet should be unable to decompose these into compounds poorer in carbon? There can be no doubt there is such a temperature, but it must be far below that at present employed in the manufacture of illuminating gas from coal. Now, assuming that what I have just said is true, how shall we apply the principle with least inconvenience and smallest expense? I wish here to say, that in my opinion, as the change required is not so much in apparatus as in the conditions, that the machinery and apparatus now in use, and the general treatment of the gas from the hydraulic main till it enters the gasholder, is possibly all that is required, and that the benches now in use, by a slight modification in the retorts, and with a change in the setting, would enable us to produce and maintain just the conditions under which the very best results are ever obtained.

And now, in conclusion, as to what I consider as necessary to apply what I believe to be the correct principle is; first, a much larger retort, say three times the present capacity, and instead of charging every four hours, charge twice in twenty-four hours; in the meantime regulating and maintaining the heat at what I will call an invisible red, say from 950° to 1000°, this will produce oil in the vapor state; second, an arrangement of vessels or chambers (secondary retorts if you like) to be heated and maintained at a temperature from 1450° to 1500°, and so ample in their converting capacity as to receive at once the oil vapors, and leisurely complete the operation. I am aware of the fact, that as early as 1827 B. Chaussenot patented in France the use of one vessel heated to a low temperature, for distilling all hydrocarbon matters into rich vapors, and a second retort heated to a *high temperature* for converting these vapors into permanent gas, and many others of later dates, but there is this important difference the plan suggested contemplates a carbonizing capacity with a comparatively low heat, at least equal to the vaporizing capacity of the first retorts. Benj. Rankin.

Russian Economy in Rails.—An English paper says: Russian engineers are learningto economize. They are not, as heretofore sending their old rails to this country as such; but they are keeping them at home, and are sending to this country for iron in a partially manufactured state, with which to utilize the old rails in transforming them into new. Blooms are now being made in the Cleveland district, to be used in tops as single, or as tops and bottoms in double headed rails, in connection with the old rails, which will be employed as the center of the new rail. The slabs are cut to lengths, suitable for the piles built up of the old rails, and they are being made of a quality of iron of extra hardness. Perhaps 600 tons of these slabs are sufficient, with the requisite old rails, to make 2000 tons of new rails. The economy therefore, which the Russian engineers are adopting, tells upon the demand for rails for Russia, which was previously expressed by existing companies at the iron works of this country.—*Van Nostrand's Magazine.*

Gas-Light Intelligence.

United States.

The People's Gas-Light Company, of Albany, have made a contract to furnish the village of West Troy with gas. The contract provides for furnishing that village with twelve millions feet of gas annually. The works of this company are sufficiently large, and this addition to their business must add greatly to their financial prospects.—*Troy Daily Press.*

PRICE OF GAS REDUCED.—The Citizens' Gas Light Company in Brooklyn, in view of the reduced prices in coal, yesterday cut down the price of gas to private consumers from $2.75 to $2.50 a thousand feet. The company, of which Mr. W. P. Libby is President, is one of the most prosperous in the city. There was an increase in application for meters as soon as the reduction was made known.—*N. Y. Sun.*

CHEATING A GAS COMPANY.—Frederick Delmer, for fraudulently attaching a pipe to the main-service pipe of the Manhattan Gas Company at his residence, 232 East Ninth street, was held to answer in $1,000 bail at Essex Market Police Court.—*World.*

IRON PURIFICATION—SPONTANEOUS COMBUSTION.—Last evening the attendants at the gas works in this city, discovered smoke issuing from a pile of iron filings or borings, and saw dust, lying on the lime bed The boards against which it was lying were charred and had just began to blaze when discovered and was extinguished with a few dipperfulls of water. But for its timely discovery it would soon have destroyed the old shed and water tank adjacent to the works, but would probably have resulted in nothing more serious, as the main building is constructed of brick and would have been easily saved. It seems that the fire was caused from spontaneous combustion, as it can be accounted for upon no other supposition. The iron filings and saw-dust in which the fire originated, were some which after being rusted had been used to purify the gas with, and after being used was laid on the lime bed in the open air to revivify. The chemical change taking place in the mass is supposed to have produced spontaneous combustion, and set fire to the boards against which it was lying. Here is another opportunity for the "savants" to display their wisdom and erudition in explaining the numerous chemical combinations which will, under certain complications and circumstances, produce fire.—*Salem (Oregon) Mercury. Aug.* 12.

Chemical and Scientific Repertory.

SCHOOLROOMS.—Repeated experiment has proved that in school-rooms lighted by windows on both sides the children suffer more or less from injured vision; and so important has the subject been considered in Germany, that a law has been passed forbidding such windows in schools.—*Evening Post.*

A NEW OBSERVATORY.—Mr. Floyd, of San Francisco, the president of the Board of Trustees of the Lick Donaiton, has been consulting Levarrier, in Paris, as to the construction and furnishing of the proposed Lick Observatory, and the grounds of the Paris Observatory have been thrown open for his use in making experiments with large apparatus. A refracting telescope with a lens one meter in diameter will doubtless be made in Europe at some of the celebrated factories.—*Ibid.*

SOUNDS.—Experiments made by Prof. Mayer seem to show that some sounds, or sounds of different pitch, will obliterate the sensations of others, and that this effect is produced at different distances. If this is sustained, one of the practical results would be to modify the composition and performance of orchestras, in order, in the various combination of sounds, to provide that one does not improperly affect or obliterate another.—*Amer. Exchange and Review.*

DECISION OF A PATENT.—By a recent decision of Judge Benedict (U. S. Circuit Court, E. D., New York) the patent of Nelson W. Green, dated May 9, 1871, for a drive well is sustained. The decision covers many practical points and contains much of interest as showing the trials and impediments with which an inventor has sometimes to contend. Should the decision be sustained on appeal to the Supreme Court of the United States, a large number of wells will be made tributary to the patent; it having been testified to that there are now 150,000 driven wells in operation in the State of New York alone.—*Ibid.*

OEIVE OIL.—This oil, says the *English Mechanic*, has been made in Greece for years in a very primitive way, and the refuse from the rude screw presses was used for fuel or as manure, Although not actually wasted, the refuse was not fairly treated; and some one having discovered that it contained 3 per cent. of pure oil, works were put up for extracting it by means of bisulphide of carbon. The machinery required involved the outlay of considerable capital; but the speculation has proved a complete success, a profit of about 25 per cent. being made annually. The oil is mainly used for the manufacture of fine soaps, nearly all the produce of the works being consignee to Marseilles.—*Jour. Society of Arts.*

PROF. CROOKE'S RADIOMETER.—In a discussion by the Paris Academy of Sciences on the cause of the movements in Prof. Crooke's radiometer, M. Govi rejected the idea of an impulsive force of light and of thermal currents of gas in the receiver; the cause he assigned was the dilatation by heat, or condensation by cold, of gaseous layers which all bodies retain at their surface, even in an absolute vacuum. It should be possible to obtain insensible radiometers, by heating the vanes during the action of the mercury pump. M. Fizeau said that the constant motion, for as long as an hour, of a radiometer placed in the centre of a circle of candles was against this hypothesis.—*Evening Post.*

STEEL BELTING.—Dr. William Fields, of Wilmington, Del., has applied for a patent for steel belting. The Wilmington *Republican* says: "Any good tough steel will answer the purpose. The great superiority of steel belting over that of leather is first its cheapness, not costing by one-third as much as that of leather; second, it will not stretch or get out of shape; third, it is quickly made, as there is an inexhaustible supply of the crude material in this country. Steel can be made at two and a-half cents per pound, and rolled into belting for two and a-half cents more. It don't require to be more than a sixteenth of an inch in thickness for most of the belting, consequently it will not weigh much per foot. The doctor's process for slackening and tightening the belts in a few seconds, without disturbing the joinings, is also a great advantage over the strings and facings now in use. The invention is an important one, and calculated to be of great service to manufacturers.

ICE HOUSE.—An exchange states that they are erecting a building for the manufacture of ice at New Orleans. It is to be 115 by 150 feet, 50 feet to the eaves, and with walls 3½ feet thick, which are triple, with air spaces and sawdust between the walls. The interior contains over 5000 three inch iron tubes, 36 feet high, placed upright in pairs, each pair being connected at top and bottom. Vaporized ammonia, forced through these tubes by steam power, reduces their temperature below zero; and water dashed upon them in a spray freezes upon them, gradually forming an ice coating which is 36 feet long, and often 2½ feet thick. When the process is completed, the ice is sawn off the tubes. Only one half the tubes will be used this season, but they will be able to turn out 80 tons of ice a day.—*Amer. Architect and Building News.*

Lightning and Oil Tanks.

Scarcely a thunder storm occurs of late without the destruction of thousands of barrels of petroleum contained in the large iron tanks in the oil regions and elsewhere. Nor does it seem that in spite of the frequent and heavy losses thereby arising that any adequate means have been devised to remedy or even mitigate the evil.

There is no more reason that an oil tank should be struck than a house or hay stack, though in reality the damage by lightning to the former is totally out of proportion to that done to the latter objects.

There is perhaps no subject so little understood among the people generally as that of electricity, and after every case of the destruction of a tank and many thousands of barrels of oil, we hear expressed the crudest theories and wildest reasoning as to the "why and wherefore" of the "accident."

It is estimated that during this year there have been over 250,000 barrels of oil destroyed by fire resulting from lightning alone, and all this oil was contained in iron tanks. The last large fire—at Dilk's station, on W. P. R. R.—consumed the oil in tanks thoroughly protected—as supposed—by lightening rods. But we are informed that the rods instead of being attached directly to the tanks were at some distance from them. Thus the slight body of metal in the rods could offer but little inducement to the lightning compared with the heavy mass of conducting metal in the tank itself. As to the oil itself its conductivity is almost *nil* and ranks among the best of insulators.

Lightning, in passing from the clouds to the earth or *vice versa*, always does in traveling what we try to do, that is it travels by the most direct route when the conveyance suits, if not it takes a more pleasant conveyance, even if it has to go further around to reach its destination.

In all these cases the tanks offered a better route to its destination than did the slight rods, and it used the tanks in the same way it would use a tree or haystack, or house, preferably taking, in doing so, the object offering the least resistance and easiest passage. This is on the supposition that the tanks were directly struck. But the main reason why oil tanks are so frequently destroyed lies in their pipe-line connections. These lines stretch from tank to tank, and in an unbroken line extend for many miles. Consequently should any object in connection with the pipeline be struck, even miles away, it is instantaneously transmitted to the tanks. Now if these tanks were in connection with the earth, it is probable that the tank would be uninjured, and the body of metal being large, it would transmit the electricity to the earth without damage. But somebody says: "Do not the tanks rest on the ground, and why, then, does not the lightning easily make its escape without damage?" We should have to say that between the tank and the ground there is generally a little oil covering its bottom. This oil being an insulator—or practically so—or a substance refusing to conduct, the electricity, in passing through, even a slight film of oil interposed between the tank and earth, encounters so much resistance as to set fire to the oil on the bottom, which is easily transmitted by the vapor, spilled oil, &c., to the top of the tank. This accounts for the simultaneous ignition of several tanks. The writer knows of one case where several tanks were set on fire at once, although at such distance as would preclude the possibility of one communicating fire to the other, and the outlet of the condenser of a still ignited at the same time, although a great distance away. All these were connected by a pipe line.

There is no doubt but that our efficient system of copper lightning rods attached directly to the tank—without insulators—and extending into the earth some distance from the tank, with ground terminals of the same material and large surface, would effectually lessen the liability to injury by electrical discharges.

The ordinary system of lightning rods either for this purpose or for dwellings is a farce and rather a source of danger than protection, and we think the lightning-rod man, the patent medicine man and tramp not only a mild nuisance but a positive evil. Unless some means are used to prevent these now frequent fires caused by lightning, the insurance companies will either refuse to take risks or charge such rates as will materially increase the price of oil.—*American Manufacturer.*

THE AMERICAN GAS LIGHT JOURNAL AND CHEMICAL REPERTORY

A. M. CALLENDER & CO.,

PROPRIETORS.

Editor—G. WARREN DRESSER.

PUBLISHED ON THE 2ND AND 16TH OF EACH MONTH

At No. 42 Pine Street, New York.

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LIGHT, HEAT, MINING INTERESTS, STEAM, WATER-SUPPLY, PATENTED INVENTIONS, VENTILATION, SANITARY IMPOVEMENT, AND GENERAL CHEMICAL SCIENCE.

TERMS

SUBSCRIPTION—Three Dollars per annum, in advance.

AGENTS

NEW YORK—AMERICAN NEWS COMPANY, 119 and 121 Nassau St
BOSTON—S. M. PETTENGILL & Co., 6 State Street.
PHILADELPHIA—COE, WETHERILL & Co., Ledger Buildings, Phila.
Germany—B. WESTERMANN & Co., of New York.

SATURDAY, SEPTEMBER 2, 1876.

The Mechanical Action of Light.

A Lecture delivered at the Royal Institution. London.

By W. CROOKES, F R. S.

The speed with which a sensitive radiometer will revolve in the sun is almost incredible; and the electric light such as I have it in this lantern cannot be far short of full sunshine. Here is the most sensitive instrument I have yet made, and I project its image on the screen, letting the full blaze of the electric light shine upon it. Nothing is seen but an undefined nebulous ring, which becomes at times almost invisible. The number of revolutions per second cannot be counted, but they must be several hundreds, for one candle has made it spin round forty times a second.

I have called the instrument the radiometer because it will enable me to measure the intensity of radiation falling on it by counting the revolutions in a given time; the law being that the rapidity of revo lution is inversely as the square of the distance between the light and the instrument.

When exposed to different numbers of candles at the same distance off, the speed of revolution in a given time is in proportion to the number of candles: two candles giving twice the rapidity of one candle, and three, three times, etc.

The position of the light in the horizontal plane of the instrument is of no consequence, provided the distance is not altered; thus two candles, one foot off, give the same number of revolutions per second, whether they are side by side or opposite to each other. From this it follows that if the radiometer is brought into a uniformly lighted space it will continue to revolve.

It is to get rotation in a radiometer without having the surfaces of the disks differently colored. Here is one having the pith disks blacked on both sides. I project its image on the screen, and there is no movement. I bring a candle near it, and shade the light from one side, when rapid rotation is produced, which is at once altered in direction by moving the shade to the other side.

I have arranged here a radiometer so that it can be made to move by a very faint light, and at the same time its rotation is easily followed by all present. In this bulb is a large six-armed radiometer carrying a mirror in its center. The mirror is almost horizontal, but not quite so, and therefore when I throw a beam of electric light vertically downwards on to the central mirror, the light is reflected off at a slight angle, and as the instrument rotates its movement is shown by the spot of light travelling round the ceiling in a circle. Here again the fog helps us, for it gives us an imponderable beam of light moving round the room like a solid body, and saving you the trouble of looking up to the ceiling. I now set the radiometer moving round by the light of a candle, and I want to show you that colored light does not very much interfere with the movement. I place yellow glass in front, and the movement is scarcely diminished at all. Very deep colored glass, you see, diminishes it a little more. Blue and green glass make it go a little slower, but still do not diminish the speed one-half. I now place a screen of water in front: the instruments moves with diminished velocity, rotating with about one-fourth its original speed.

Taking the action produced by a candle flame as 100

Yellow glass reduces it to	89
Red " " "	71
Blue " " "	56
Green " " "	56
Water " "	26
Alum " "	15

I now move the candle a little distance off, so as to make the instrument move slower, and bring a flask of boiling water close to it. See what happens. The luminous index no longer moves steadily, but jerks. Each disk appears to come up to the boiling water with difficulty, and to hurry past it. More and more sluggishly do they move past, until now one has failed to get by, and the luminous beam, after oscillating to and fro a few times, comes to rest. I now gradually bring the candle near. The index shows no movement. Nearer still. There is now a commencement of motion, as if the radiometer was trying to push past the resistance offered by the hot water; but it is not until I have brought the candle to within a few inches of the glass globe that rotation is commenced. On these pith radiometers the action of dark heat is to repel the black and white surfaces almost equally, and this repulsion is so energetic as to overcome the rotation caused by the candle, and to stop the instrument.

With a radiometer constructed of a good conductor of heat, such as metal, the action of dark heat is different. Here is one made of silvered copper, polished on one side and lampblacked on the other. I have set it moving with a candle slightly the normal way. Here is a glass heated so that it feels decidedly warm to the hand. I cover the radiometer with it, and the rotation first stops, and then recommences the reverse way. On removing the hot shade the reverse movement ceases, and normal rotation commences.

If, however, I place a hot glass shade over a pith radiometer the arms at once revolve the normal way, as if I had exposed the instrument to light. The diametrically opposite behavior of a pith and a metal instrument when exposed to the dark heat radiated from a hot glass shade is very striking. The explanation of the action is not easy, but it depends on the fact that the metal is one of the best conductors of heat, whilst pith is one of the worst.

One more experiment with this metalic radiometer. I heat it strongly with a spirit-lamp, and the arms spin round rapidly. Now the whole bulb is hot, and I remove the lamp: see what happens. The rotation quickly diminishes. Now it is at rest; and now it is spinning round just as fast the reverse way. I can produce this reverse movement only with difficulty with a pith instrument. The action is due to the metal being a good conductor of heat. As it absorbs heat it moves one way; as it radiates heat it moves the opposite way.

At first I made these instruments of the very lightest material possible, some of them not weighing more than half a grain; and where extreme sensitiveness is required lightness is essential. But the force which carries them round is quite strong enough to move a much greater weight. Thus the metalic instrument I have just experimented with weighs over 13 grains, and here is one still heavier, made of four pieces of looking-glass blacked on the silvered side, which are quickly sent round by the impact of this imponderable agent, and flash the rays of light al round the room when the electric lamp is turned on the instrument.

Before dismissing this instrument let me show one more experiment. I place the looking-glass and thel metal radiometer side by side, and, screening the light from them, they come almost to rest. Their temperature is the same as that of the room. What will happen if I suddenly chill them? I pour a few drops of ether on each of the bulbs. Both instruments begin to revolve. But notice the difference. Whilst the movement in the case of the metal radiometer is direct, that of the looking-glass instrument is reverse And yet to a candle they both rotate the same way, the black being repelled.

Now, having found that this force would carry round a comparatively heavy weight, another useful application suggested itself. If I can carry round heavy mirrors or plates of copper, I can carry round a magnet. Here, then is an instrument carrying a magnet, and outside is a smaller magnet, delicately balanced in a vertical position, having the south pole at the top and the north pole at the bottom. As the inside magnet comes round, the outside magnet, being delicately suspended on its center, bows backward and forwards, and, making contact at the bottom, carries an electric current from a battery to a Morse instrument. A ribbon of paper is drawn through the "Morse" by clockwork, and at each contact—at each revolution of the radiometer—a record is printed on the strip of paper by dots; close together if the radiometer revolves quickly, farther apart if it goes slower.—*The Polytechnic Review.*

The Hudson River Tunnel.

Active preparations are now in progress for the construction of the Hudson River tunnel on the Jersey shore. The entrance to the tunnel is located on Jersey avenue, near Fifteenth street, and the excavation will be carried in a north-easterly direction, terminating in Washington Square, New York. The tunnel will be two miles in length and it is calculated the cars will pass through it in three minutes, The road bed will be twenty-three feet in width. The shaft at the foot of Fifteenth street, Jersey City, is 100 feet in circumference and the brick wall is 3 feet and 4 inch ⅔ thick. The shaft has been sunk to the depth of 20 feet, and will be further excavated to the depth of 62 feet, when the excavation beneath the river will be commenced. The machinery for the work is now in position, and it is stated that the excavation of the shaft will be completed within twenty days. The eastern grade of t he tunnel is two in a hundred feet, descending from Jersey City, then ascending on the New York side two in a hundred feet. As soon as the shaft is sunk to the required depth, a few feet will be excavated in the tunnel, when an iron cylinder with hinged doors will be inserted, so that the laborers can proceed with the work. Compressed air will be forced from the surface into the cavity. Very little blasting will be necessary, the first vein of rock being 1,100 feet from the New York side, and the rock is soft. The depth of earth over the masonry will not be less in any part than 35 feet, so that no injury can occur from the anchorage of vessels. The cost of this stupendous enterprise will be $15,000,000, of which $10,000,000 has been already subscribed. After several legal contests the Hudson River Tunnel Company has been triumphant, and the president, Col. Haskin, declares his determination to proceed vigorously with the work.—*N. Y. Herald.*

Price of Gas.

The following prices are *official*, having been furnished to the AMERICAN GAS-LIGHT JOURNAL by the officers of the various Gas Companies.

Albany (Peoples) N. Y.	$2.75	
Annapolis, Md.	3.40	
Atchison, Kansas.	4.50	
Austin, Texas.	6.00	
Allegheny City, Pa.	1.80	20 p. ct. off prompt pay
Albany, N. Y.	2.75	
Ashland, Ohio.	3.50	Street lamps 4½ hours 17 nights per month $15 per annum.
Augusta, Ga.	4.00	Net.
Anderson, Ind.	3.50	Crude petroleum.
Ashtabula, Ohio.	2.00	Wren's process; $10 for 80 candle gas.
Auburn, N Y.	3.50	5 p c off prompt pay.
Allentown, Pa.	2.50	$18 per an street lamps Meter rent 10 cents per month.
Ashland, Pa.	10.00	70 candle gas, 10 p c off prompt pay. Patton's process.
Brooklyn, B'klyn.	2.75	

Brooklyn, Citizens....	2.75	
" Nassau.....	2.75	
" Metropol'an	2.75	
" Peoples.....	2.75	
" W'msburgh	2.75	
Brockton, Mass.	3.80	
Batavia, N: Y.....	3.00	
Bridgton, N. J.....	3.50	
Bangor, Me.....	3.00	
Boonville, Mo.....	4.50	
Brownsville, Tenn.....	4.50	
Belfast, Maine.....	4.00	10 p. c. off bills over $10; 5 p. c. off bills under $10.
Brockville, Ontario....	3.75	
Bloomfield, N J.....	3.75	
Belleville, Ill.....	3.50	
Bellaire, Ohio.....	2.85	5 p ct. off prompt pay.
Barnesville, Ohio.....	3.00	5 p ct. off prompt pay. Street lamps $17.50 per ann. Burn till 12 P. M. on moonless nights.
Boston, Mass.....	2.25	
Bath, Maine.....	4.00	12½ p c off prompt pay.
Bayonne City, N. J....	4.00	Net.
Binghampton, N. Y...	4.00	10 p c off prompt pay on bills for 1000 per month.
Buffalo G L Co., N Y.	2.50	10 p c off prompt pay.
Buffalo Mutual, N Y...	2.50	10 p c off prompt pay.
Buffalo Citizens, N Y.	2.50	10 p c off prompt pay.
Bloomsburg, Pa.....	10.00	70 candle gas, 10 p c off prompt pay. Patton's process.
Burlington, Iowa.....	3.75	15 p c off bills of $100, and 2c p c over $200. Street lamps $25.22 each, per annum.
Cleveland, Peoples, O	2.00	
Cumberland, Md.....	3 00	
Charleston, W. Va.....	4.00	25 p. ct. off prompt pay Meter rent 25, 30, and 50 cents. per m. for 3, 5 and 10 light.
Cincinnati, Ohio.....	2.25	
Columbia, Mo.....	4.50	
Carondolet, South St. Louis, Mo.....	3.00	5 p. ct. off prompt pay,
Chattanooga, Tenn.....	3.00	
Cold Water, Mich.....	3.25	
Chicago, Ill.....	2.50	
Columbia, Pa.....	2.85	Lowe process.
Charlottesville, Va.....	2.50	Meter rent 20 cents.
Cedar Rapids, Iowa....	4.50	50 cts p M. off prompt pay.
Cairo, Ill.....	3.75	50 cts added if not paid by the 5th.
Cortland, N. Y.....	4.00	25 cts p M. off prompt pay.
Cairo, Ill.....	3.75	50 cents per month off prompt pay. For 20,000 feet a month $2.50.
Chillicothe, Ohio.....	3.00	
Camden, N. J.....	3.16	5 p c off prompt pay; 10 p c off for 100,000 per year.
Carson City, Nevada...	8.00	Gas from wood and Cannel coal.
Cadiz, Ohio.....	3.50	10 p c off on 500 feet or less; 50 cts per M. on from 500 to 2000; 20 p c off on 2000 and upwards.
Derby, Conn.....	3.60	10 p. c. off prompt pay, and 50 cts per M. on excess of 5000 ft. per month.
Decatur, Ill.....	3.50	50 cts. per M. added, if not paid by 10th.
Danbury, Conn.....	4.28	For less than 5000 per month.
" "	3.85	For over 5000 per m th
Dover, Del.....	3.60	
Dunkirk, N Y.....	2.50	Street lamps till 12, moonless nights $25 per annum.
Defiance, Ohio.....	10.00	70 candle gas, 20 p c off prompt pay. Patton's process.
Delaware, Ohio.....	3.00	No charge for meter.
East Boston, Mass.....	3.00	
East St. Louis, Ill.....	3.50	5 p. c. off prompt pay.
Evansville, Ind.....	3.00	City lamps $30.
Erie, Pa.....	3.00	City lamps $28 p. an.
Elkhart, Ind.....	3.50	
East Newark, N. J.....	4 00	
Eastchester, N. Y.....	3.50	
Elizabethtown, N. J...	3.00	
East N Y (Union) L I.	3.00	
Eastport, Me.....	4.00	
Fredericksburg, Va.....	3.40	
Flint, Mich.....	3.50	
Franklin, Pa.....	3.00	
Fall River, Mass.....	3.00	
Freeport, Ill.....	3.80	
Fort Scott, Kansas....	4.50	
Flatbush, L. I.....	3.50	
Fredonia, N. Y.....	3.00	Street lamps $25 per annum; burn fill 12 P. M.
Guelph, Ontario.....	3,50	
Geneva, N, Y.....	2.50	5 p. c. off prompt pay. Wood and oil gas.
Greensboro, N. C.....	4.00	
Galena, Ill.....	4.50	Meter rent 25 cts. per month.
" "	4.00	After September 1st.
Grand Rapiids, Mch..	2.80	For less than 1000 feet per month.
" " "	2.50	For over 1000 eet per month. 10 per ct discount on 300,000 ft annually
Gloucester, N. J.....	3.15	5 p c off prompt pay.
Greenwich, Conn.....	2.40	Wren's process
Goshen, Ind.....	10.00	70 candle gas, 20 p c off prompt pay. Patton's process.
Huntsville, Ala.....	3.50	
Hempstead, L. I.....	4.00	
Huntingdon, Pa.....	3.80	10 per ct. off prompt pay.
Hagerstown, Md.....	3.75	
Hamilton, Ohio.....	4.00	
Hillsdale, Mich.....	3.50	
Holyoke, Mass.....	3.01	
Hartford, Conn.....	2.75	
Hornellsville, N. Y....	3.50	50 cents per 1000 off prompt pay.
Honesdal e, Pa.....	4.00	12½ cents meter rent per month.
Hannibal, Mo.....	3.00	No meter rent.
Ithaca, N. Y.....	4.00	5 p. c. off prompt pay.
Indianapolis, Ind.....	2.50	
Indiana, Pa.....	3.00	10 p. c. off prom pay Meter rent 0 cents per month.
Jersey City, N. J.....	2.75	
Joliet, Ill.....	3.50	
Jacksonville, Ill.....	4.00	12½ p.c. off prompt pay.
Jefferson City, New Orleans, La.....	4.00	
Johnstown, N Y.....	3.50	
Knoxville, Tenn.....	3.00	Meter rent 15 cents.
Lyons, N. Y.....	4.00	
Lima, Ohio.....	3.80	
Lynchburgh, Va.....	3.00	5 p. ct. added to bills not paid in 5 days.
Louisiana, Mo.....	4.50	
La Crosse, Wis.....	4.50	50 cents per M. off prompt pay.
Lancaster, Pa.....	3.00	
Louisville, Ky.....	2.70	5 p. c. off prompt pay.
La Porte, Ind.....	3.50	Wood and oil gas.
Lowell, Mass.....	2.50	25 cents per 1000 off prompt pay.
Lafayette, Ind.....	2.75	
Lexington, Mass.....	2-40	Wren's process.
Los Angelos, Cal.....	6.00	
Lockport, N Y.....	3.20	Less 20 p c per M. if paid within 30 days.
Millville, N. J.....	3.12	
Milford, Del.....	3-50	
Marquette, Mich.....	3.50	
Morris, Ill.....	2.00	For 15 candle power, or $10 per M. coal gas meter measure (Petroleum Gas—Wren's patent).
Meriden, Conn.....	3.93	
Marietta, Ohio.....	3.50	20 cts. per M. off if paid by 6th. Consumers over 3000 ft. 30 cts. additional discount.
Marshalltown, Iowa...	4.50	50 cts p M. off prompt pay.
Meadville, Pa.....	3.50	25 cts p M. off prompt pay.
" '	2.50	For over 10,000 ft. per month,
Madison, Ind.....	3.75	25 p c off if paid in five days: 25 to 40 cents per month meter rent.
Monroe, Mich.....	3.50	5 per ct off prompt pay
Malone, N. Y.....	4.50	
Middletown, Conn....	3.56	Net.
Mount Sterling, Ky....	4.50	
Monongahela, Pa.....	2.75	Under 5000 feet m'th $2.75 per M.; over 5000 feet per month $2.50 per M.
Minneapolis, Minn....	5.00	10 p c off prompt pay.
Mahanoy City, Pa.....	10.00	70 candle; 20 p c off prompt pay. Patton's process
Morristown, Pa.....	3.00	18 candle coal, an
New York, New York.	2.50	
" " Harlem....	2.75	
" " Manhattan	2.50	
" " Mutual.....	2.50	
" " Mropolitan	2.50	
" " Municipal.	2.50	Water Gas.
Nashville, Tenn.....	2.85	
Newark, Citizens, N.J.	2.85	
Norfolk, Va.....	3.10	
New Brunswick, N. J.	2.70	
Newton, N. J.....	4.00	
North Attleboro, Mass.	3.50	
New Britain, Conn.....	3.70	
New Haven, Conn.....	2.75	
Nantucket, Mass.....	3.00	Meter rent 15 cts. p. m.
Newark, N. J.....	2.85	
Niagara Falls, N. Y....	3.50	20 cts p M. off prompt pay.
Norwalk, Conn. ..	4.00	12½ p ct off prompt pay.
New Albany, Ind.....	3.00	
New City, Montreal...	2.50	Street lamps, $22 p a
Oswego N. Y.....	3.15	5 p. c. off prompt pay.
Ottawa,, Ill.....	4.00	12½ p. c. off promptpay
Omaha, Nebraska.....	5.00	
P'keepsie, Citizens....	2.70	Gwynne Harris process
Paterson, N. J.....	3.80	10 p c. off prompt pay, and in addition 5 p.c. on bills of $200; 10 p. c. on bills of $1000
Portchester, N. Y.....	3.50	
Pittsfield, Mass.....	3.50	5 p. c. off prompt pay, and 10 p. c. off on bills of $350 per an
Portland, Me.....	3.00	
Paris, Ky.....	4.50	Meter rent 25 cts. p m.
Portsmouth, N. H.....	3.22	
Pittsburgh, Pa.....	1.00	
Philadelphia, Pa.....	2.15	
Painesville, Ohio.....	3.50	
Pawtucket, R. I.....	2.80	5 p c allowed on bills of $500, and 10 p c on bills of $1500 for six months.
Providence, R. I.....	2.25	
Pottsville, Pa.....	3.50	10 p ct off promp pay,
Plainfield, N. J.....	3.50	5 p ct off for less than 5000 a month. 10 per cent more than 5000 a month.
Peoria, Ill.....	3.50	
Paducah, Ky.....	4.00	10 p c off prompt pay.
Plymouth, Pa.....	10.00	70 candle. Patton's process.
Pottstown, Pa.....	3.20	Public lamps till 11 P. M., 18 nights per month $20 per lamp.
Ponghkeepsie, N Y....	2.60	10 p c off prompt pay
Port Huron, Mich.....	3.50	
Quincy, Citizens, Mass.	5.00	
Quincy, Ill.....	3.50	
Quebec, Ont.....	2.40	
Rome, N. Y.....	3.60	
Rochester, N. Y.....	3.00	
" Citixens...	3.00	
Rondout, N Y.....	3.60	
Rockford, Ill.....	4.00	5 p c off prompt pay; 10 to 25 p c off on bills for 500 to 25 M, feet per month.
Richmond, Ind.....	3.00	50 cents added if not paid by 20th.
Syracuse, N. Y.....	2.75	
Springfield, Ill.....	3.25	$25 for city lamps.
St. Joseph, Mo.....	4.00	12½ p. ct. off on bills over $100 p. month.
St. Albans, Vt.....	5.00	10 p. c. off prompt pay, and in addition 5 p. c. off bills from $50 to $100 per month; 10 per. ct. off bills over $100.
Sandusky, Ohio.	3.00	
Saratoga, N. Y.....	5.00	20 p. c. off prompt pay, Nov. 1st to May 1st. 10 p. c. rest of year.
San Antonio, Texas....	7.00	10 per ct off from 10 to 20,000 per month 20 p ct off from 20,000 and upwards.
St. Charles, Mo.....	4.50	
Sidney, Ohio.....	3.25	
Steubenville, Ohio.....	2.50	
Sherman, Texas.....	5.00	5, 10, 15 and 20 p. c. off, according to quantity.
Salem, Oregon.....	7.00	October last reduced from $8.
Salem, Ohio.....	2.75	Meter rent 12½ cts if 300 feet is not used monthly

Sedalia, Mo	3.50	
Sharon, Pa	3.15	5 per ct off on less than 5000 feet per month. 10 p ct from 5 to 15 M. 15 p ct from 15 to 20 M. 20 per ct over 40 M.
Shreveport, La	5.00	
Shelbyville, Ind	2.00	Wren's process; $10 for 80 candle gas.
Shenandoah, Pa	10·00	70 candle. Patton's process.
Shamokin. Pa	10.00	70 candle. Patton s process.
Sunbury, Pa	10.00	70 candle. Patton's process.
Tiffin, Ohio	3.00	
Titusville, Pa	3.00	
Tidioute, Pa	2.00	Wren's process.
Vicksburgh, Miss	4.50	
Wilkesbarre, Pa	3 50	10 p. c. off prompt pay.
Worcester, Mass	3.00	5 p. c. off on $500, and 10 p. c. off on $1000 in six months.
Westfield, N. Y	4.00	10 p. c. off prompt pay.
Washington, D. C	2.25	
Watertown, N. Y	4.50	10 p. c. off prompt pay.
Wheeling, West Va	2.25	10 p ct off prompt pay.
Washington, Pa	2.50	
Woburn, Mass	3.00	
Waterbury, Conn	3.50	5 p c off on biils of $50 10 p c off on bills of $100. 5 p c added if not paid by 10th.
York, Pa	3.00	Meter rent 12½ cents.
Youngstown, Ohio	2.50	10 p. c. off on bills of $50 per month.
Waterbury, Conn	3.00	5 p c off on bills of $50, 10 p c off on bills of $100; 10 p c added if not paid by 10th.
Washington, C H., O.	1.20	Wren's process; $6 for 80 candle gas.
Wilmington, Del	2.50	Street lamps 3,650 hrs per year, $31.50 per lamp.
Zanesville, Ohio	2.70	10 p. c. off on bills of $25 per month; city lamps $23.

Gas Stocks.

Quotations by W. R. Scott & Co., Bankers,

24 Pine Street, New York City.

September 2, 1876.

☞ All communications will receive particular attention

Gas. Co.'s of N. Y. City.

	Capital.	Par.	Bid.	Asked.
Harlem	$1,850,000	50	115	120
Manhattan	4,000,000	50	240	...
Metropolitan	2,500,000	100	145	150
" Scrip	$1,000,000	..	102	—
" Bonds	500,000	1000	104	—
Mutual	5,000,000	100	109	111½
" Bonds, gold.	900,000	1000	105	—
New York	4,000,000	100	135	140
Jamaica, L. I	25,000	100	...	—
Jacksonville, Ill	120,000	50	82	...
Lewistown, Maine	400,000	100	50	85
Lima, Ohio	60,000	100	10	...
" Bonds	30,000		90	
Laclede, St Louis Mo	1,200,000	100	100	110
Peoples, Jersey City		...	125	135
Peoples of Albany	650,000	100	—	20
" Bonds	350,000	1000	—	—
Peoples of Baltimore		25	99	100
" Bonds			106	—
Perth Amboy		25	—	95
Rochester, N. Y		100	50	60
Richmond Co., S. I.	300,000	...	100	105
Woonsocket, R. I	150,000	100	100	...
Halifax N. S	400,000	40	148	150
Hamilton, Ontario	150,000	40	112½	
San Francisco Gas-Co., S. Fr'isco Cal.			99	100
St. Louis, Missouri	600,000	50	—	100
Stillwater, Minn	50,000	50	—	26
Suburban, W'stch'str	390,000	50	—	100
Saugerties, N. Y	15,000	100	110	115
Troy, Citizens	600,000	100	—	100
Central, Westchester	466,000	50	100	105

Gas Co.'s of Brooklyn.

Brooklyn	2,000,000	25	190	195
Citizens	1,200,000	20	85	87
" Scrip	320,000	1000	95	100
Peoples	1,000,000	10	50	55
" Bonds	$ 325,000	...	—	95
" Scrip	300,000	...	85	—
Metropolitan	1,000,000	100	70	78
Nassau	1,000,000	25	75	80
" Ctfs	700,000	1000	96	98
Williamsburgh	1,000,000	50	125	130
" Scrip		...	100	103

Out of Town Gas Companies.

Bath, Maine	70,000	100		
Buffalo Mutual, N. Y	750,000	100	—	80
" Bonds	200,000	1000	—	90
Baltimore, Md	2,000,000	100	150	170
" Ctfs., gold	1,000,000		105	—
Bayonne, N. J		100		90
Brockport, N. Y	25,000	100	...	80
Citizens, Newark	918,000	50	90	95
" " Ctfs.	53,000	—	—	—
" " Bds.	124,000	—	—	—
Derby of Conn	160,000	100	60	80
East Boston, Mass		25	132	—
Fort Wayne, Ind		100	...	—
Hannibal, Mo	100,000	100	95	100
Hartford, Conn	700,000	25	152	—
Hempstead, L	25,000	100	...	—
Jersey City	386,000	20	160	—

PRICES OF FOREIGN AND DOMESTIC GAS COALS.

[Reported Expressly for this Journal.]

September 2, 1876.

DELIVERED IN NEW YORK.

English Cannel.

Ince Hall	$17 00	@	18 00
Kirkless Hall	16 50	@	17 00

English Caking Coals.

Newcastle Gas	$5 50	@	00 00
Liverpool caking	11 50	@	12 00

British Province Coals.

Pictou			2 00
Block House—At Mines, $1.87, Gold			2 00
Caledonia—At Mines, $1.50, Gold			0 00
Little Glace Bay—At Mines, $1.75, Gold			0 00
Lingan—At Mines, $1.75, Gold			0 00
Sydney—Old Mine			3 00
" Reserve, $1.75, GoldMine			0 00
" International			— —

Duty, 75 cents per ton, gold. Freight to New York $2 00 currency. Cost of above coals delivered in New York, $4 25 @ $5.25, currency.)

Pennsylvania Coals.

Penn Gas Coal—At Amboy	$5 60	@	0 00
Westmoreland—At Amboy	5 60	@	0 00
Shafton	5 60	@	0 00

(In New York, the above coals $6 00)

Youghiogheny (at New York)	6 00	@	0 00
Waverly	6 00	@	0 00

West Virginia Coals.

MurphyRun	6 00	@	0 00
Despard	6 00	@	0 00
West Fairmont	6 00	@	0 00
American Gas Coal	6 00	@	0 00
Fairmont	6 00	@	0 00
Newburgh Orrel	6 00	@	0 00
Pinnickinick	6 00	@	00 00
Cloverhill of Virginia	6 00	@	6 00
McKenzie Compound Mixture			— —

American Cannel Coals.

Peytona of West Virginia	$10 50	@	00 00
Darlington of Pennsylvania			— —
Cannelton Cannel			10 00
Red Bank—at Philadelphia			6 50
" —at South Amboy			7 25

Asphalts.

Albertite of New Brunswick	$21 00	@	— 00
Trinidad Bitumen	— —	@	14 00

The Penn Gas Coal Company have contracted with the PittsburghGas-Light Co. for their entire supply for th ensuing year from their Youghiogheny mines.

Within the last week contracts have been made by some of the companies in New York for about 200,000 tons of Penn Westmoreland, Waverly, Youghiogheny, and the West Virginia caking coals—at $6·00 per ton a reduction of 50 cents from last years' prices.

TO GAS COMPANIES.

FOR SALE, IN LOTS TO SUIT.

TWO HOLDERS—one with Iron Columns and Girders.

HYDRAULIC (4 inch) STAND PIPES, MOUTH PIECES and Covers for two benches of Threes.

Three IRON RETORTS—Condensers, Washer, and Washer Tank.

Three Round (4 feet) PURIFIERS and Covers, with Center Seal and connecting Station Meter and several Dry Meters.

Apply at the office of this Journal. 423

WANTED TO LEASE.

A GAS WORKS OF ANY CAPACITY, FROM 1,000 TO 10,000 feet Coal Gas per day, by a practical gas maker Parties having such to lease will please send particulars to

E. W. GUILD,

4'2-2t 13 Bassett St., Providence, R. I.

Wanted to Purchase for Cash.

A GAS WORKS IN A TOWN OF FROM TEN TO FIFTEEN thousand inhabitants. Address Hamilton Gas Light and Coke Co., Hamilton, Ohio. 412

TO GAS-LIGHT COMPANIES.

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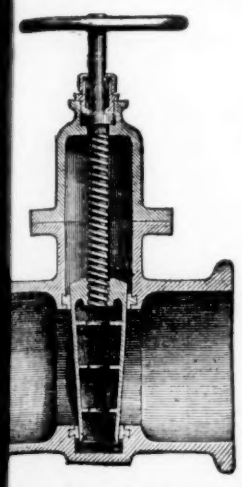

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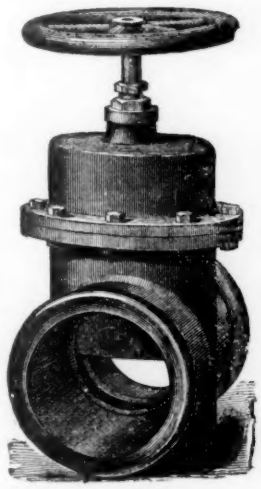

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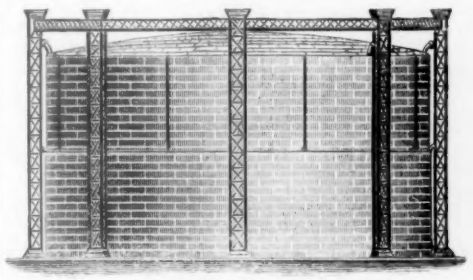

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Volatile Matter.	Coke.	Per cent. of Ash in Coal.	Per cent. of Ash in Coke.	Sulphur in Coke.	Sulphur in Ooti.	Sulphur in Volatile Matter.	Specif. Gravity. Coal.	Specif. Gravity. Gas.
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MAXIMUM YIELD, 5.06 cubic feet of Gas per pound of Coal—A yield of 4·78 cubic feet per lb.. —gave 16 14-100 Candle-Power.

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Best dry coals shipped from Locust Point, wharves, and prompt attention given to orders for chartering of vessels.

294-1y n

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355-

IMPROVED GAS EXHAUSTER,

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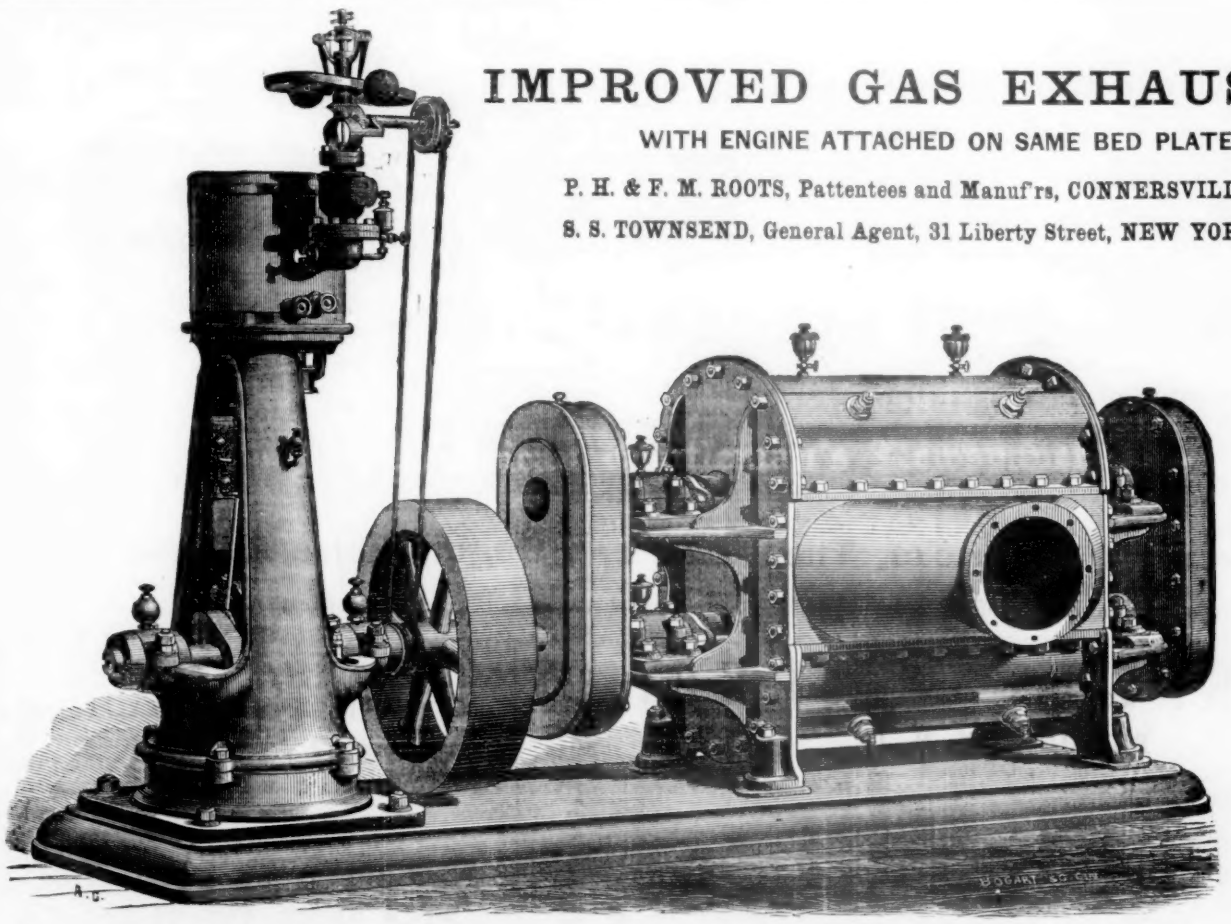

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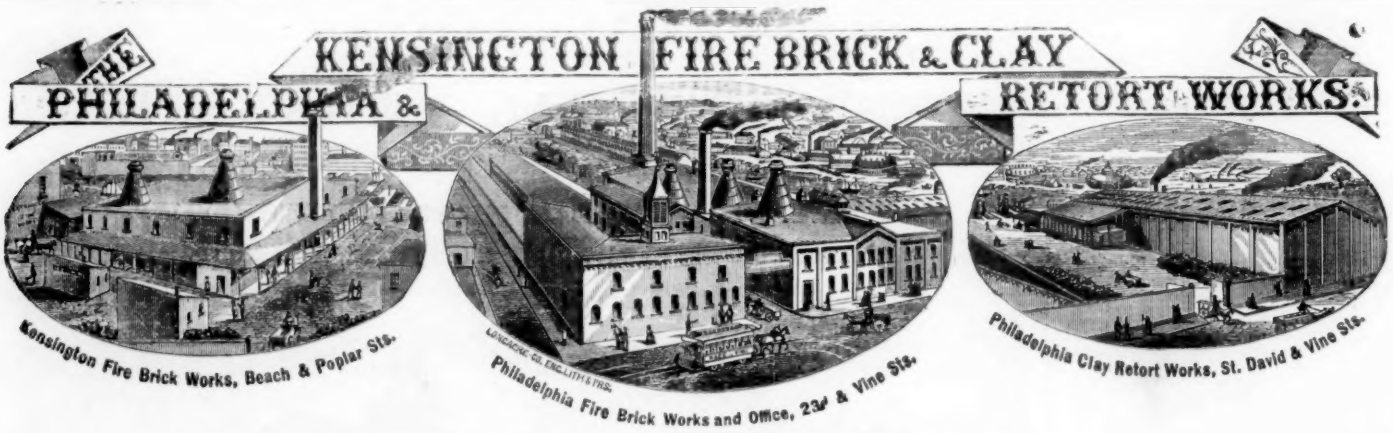
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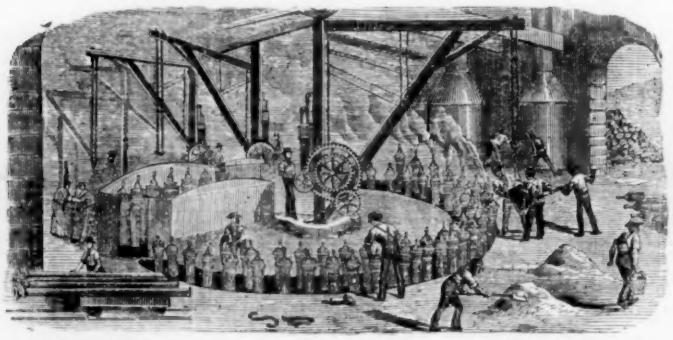

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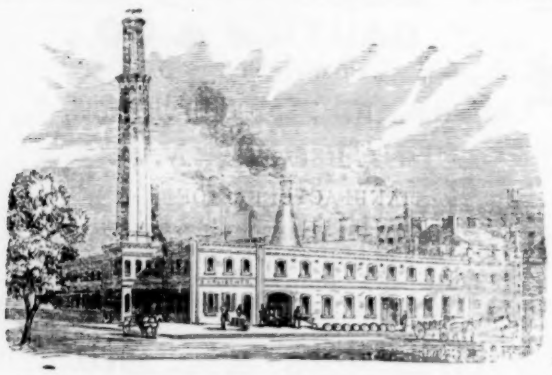
FOR WATER AND GAS.



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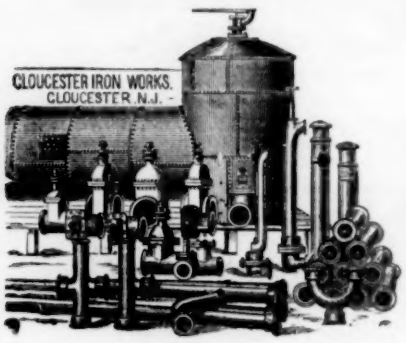

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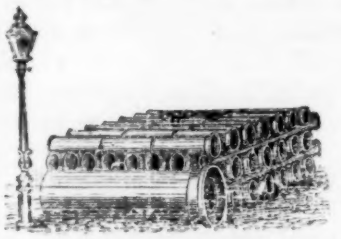

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(Pipe from three inch and upwards cast *vertically* in 12 feet lengths.)

HEAVY AND LIGHT CASTINGS OF ALL KINDS.

DAILY CAPACITY 125 *TONS.*

☞ Our Works *connect direct* with *eleven railroads* centering in this city, giving us unequalled facilities for shipping to all points, at the lowest rates of freight. 405-1y

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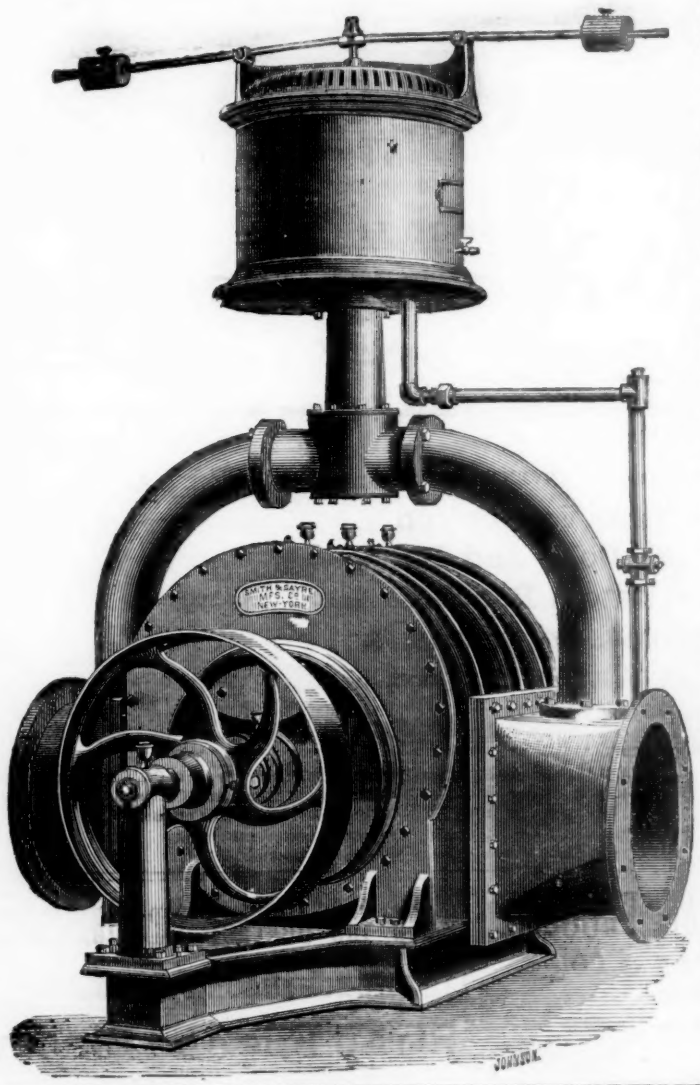
The Mackenzie Patent Gas Exhauster

And Patent Compensator.



They are made to pass from 4,000 to 150,000 cubic feet of gas per hour; will increase the production and illuminating power of the gas, and add very much to the durability of the retorts, either clay or iron. The Compensator obviates entirely the necessity of water-jo ints, is compact, durable, cleanly, not liable to get out of order, self-acting, quiet, and certain in its operation.

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The Blower is a Force Blast machine, durably built, and can be driven with one-third the power required to drive the ordinary fan

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Nos. 63 and 64 Drexel Building,

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THE GAS-LIGHT COMPANY OF AMERICA, owners of the Patent Processes for making ILLUMINATING GAS from PETROLEUM and its products, known as the

Gale and Rand

AND

Wren and Barker Patents,

are prepared to treat with Gas Companies and Manufacturers of Gas for the use of said processes.

An examination of the merits of these inventions as demonstrated by practical experience in a large number of Gas Works employing them, will not fail to convince the intelligent Gas Manufacturer of the great advantages derived from their use.

Gas of unexceptional quality, of high illuminating power is made at many of these works by these processes, at a cost of from 40 per cent. to 60 per cent. less than an ordinary quality of illuminating gas can be made by any other methods in use. Gas Companies generally may easily, and at small outlay for making the necessary changes in manufacturing apparatus, double their net earnings, and supply a much better light to their patrons, at greatly reduced prices.

The Company respectfully refer to Companies using these processes in this city, Reading, Penn., Chicago and elsewhere, and especially to the Mutual Gas-Light Company of Detroit, Mich., whose works more nearly conform in all details of construction to the original plans of the inventors than those of other Companies.

For Correspondence, etc., address to office as above.

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We are prepared to furnish Holders, Wrought Iron Roof Frames, Bench Castings, Condensers, Scrubbers, Purifiers, Drips, Bends, Tees, and all other Iron Work connected with Gas Works. Previous to 1868 our Mr. D. built *nine Gas Works* and *fifty-four Holders*. Since that date we have built *three Gas Works* and *forty-six Holders*. We *superintend in person* the erection of all our work, and would refer to the Gas Companies at the following places, where we have built Holders, since 1868:

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Zanesville, O.
Mansfield, O.
Marion, O.
Bellevaire, O.
Athens, O.
Barnesville, O.
Franklin, Ind.
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Jefferson City, N. O., La.
Algiers, N. O., La.
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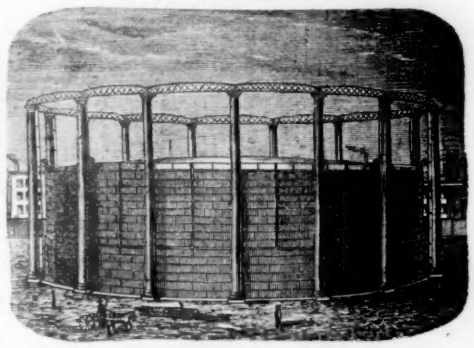

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Condensers, Scrubbers, Purifiers, Retorts, Hydraulic Mains and all other articles connected with the Manufacture and Distribution of Gas, furnished with despatch. Plans and Specifications prepared, and Proposals given for the necessary Plans for Lighting Cities, Towns, Mansions, and Manufactories.

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ALL KINDS OF CASTINGS AND APPARATUS FOR GAS WORKS,

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For Retort and other houses. Retorts and all castings required for setting them in the latest and most improved model. WASHERS, CONDENSERS, SCRUBBERS and EXHAUSTERS for relieving the Retorts from pressure. PURIFIERS, varying from 2,000 to 2,000,000 cubic feet daily purifying capacity.

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With cast iron guide and suspension frames. GAS GOVERNORS or REGULATORS, STREET MAINS, from 1¼ to 48 INCHES DIAMETER, for WATER or GAS. Street Main connections, such as BRANCHES, BENDS, DRIPS, SLEEVES, etc.

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All the Smith and Sheet Iron work required in and about Gas Works. 226-tf

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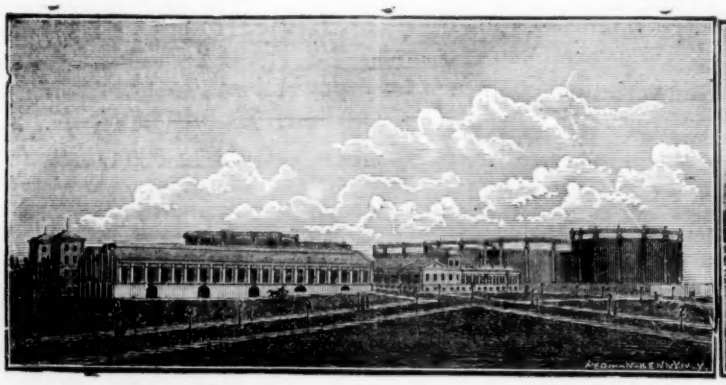
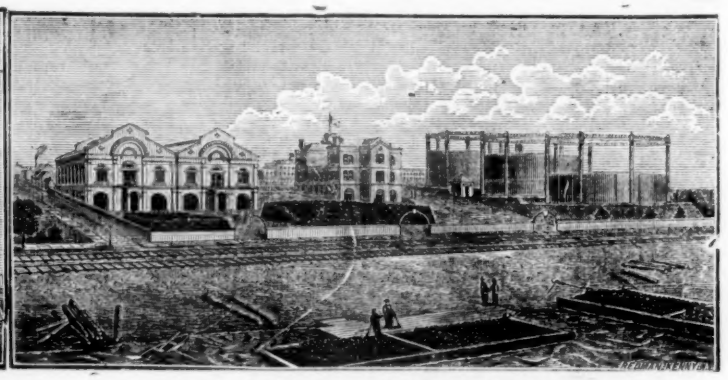


CINCINNATI GAS WORKS. ERECTED 1871-72-73.—WM FARMER, ENG.



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Exhausters for Gas and Foul Lime Ventilation,
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Hydraulic Mains for Retort Benches,
Blowers for Forges, Foundries, &c.
Pumps for Water, &c., &c.

REFERENCES:

GEN. CHAS. ROOME, President Manhattan Gas-Light Company, N. Y.
A. W. BENSON, President Brooklyn Gas-Light Company, Brooklyn, N. Y.
W. W. SCARBOROUGH, President Cincinnati Gas-Light Company, Cincinnati, Ohio.
S. L. HUSTED, President Laclede Gas-Light Company, St. Louis, Mo.
Professor B. SILLIMAN, New Haven, Conn.
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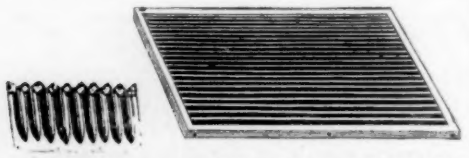
PATENTED OCTOBER 21, 1862 AND JUNE 10, 1873.



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The above Apparatus is in first rate order, and will be sold cheap. For particulars address

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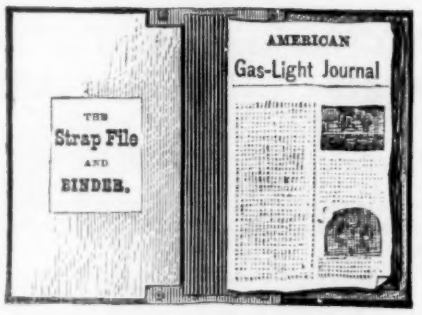

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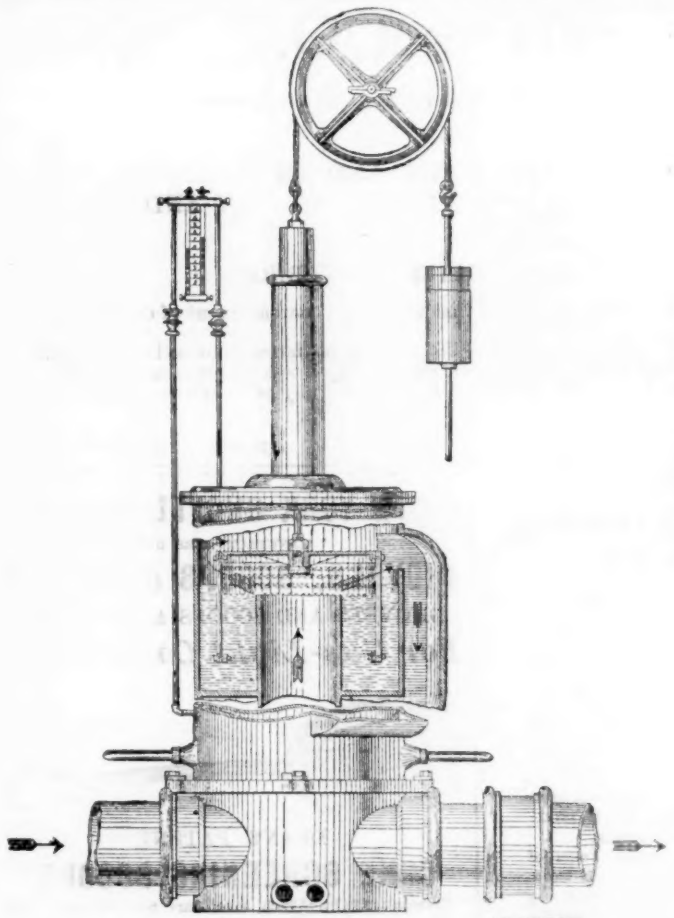

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Sole Agency for the United States.

THE

Pelouze & Audouin Condenser.

PATENT MAY 26, 1874.

With SMEDBERG'S COMBINED BYE-PASS, REVERS FLOW, and DIFFERENTIAL GAUGE.

PATENT JULY 21, 1874.

This apparatus is based upon the recent discovery by Messrs. PELOUZE & AUDOUIN of the principle of Condensation by impact, or percussion.

All gas-makers are aware how difficult it is to separate all the Coal Tar and Water from Crude Coal Gas by mere cooling; and how frequently these liquids are swept on to the purifiers, even where scrubbers or washers of large size and considerable cost are employed.

The PELOUZE & AUDOUIN CONDENSER completely arrests these by-products, increasing the quantity of Coal Tar available for fuel or sale, reducing the tendency of the purifying material to cake on the trays, and yielding a gas-liquor of remarkable strength. Hence, all the processes of purification are facilitated, while its simultaneous arrest of heavy percentages of Naphthaline reduces the risk of stoppages to a minimum.

The subordinate patent of July 21, 1874, combines a Bypass with the Condenser, and thus saves to the purchaser the cost and slow action of three valves, together with the space occupied by these valves and the necessary connections.

The Differential Gauge is so constructed that there is no oscillation of its water-columns; while it indicates inlet pressure, outer pressure, or back-pressure, at the will of the observer.

IT IS POSITIVELY GUARANTEED THAT EVERY CONDENSER SHALL BE OF PERFECT MECHANICAL CONSTRUCTION, AND SHALL DISCHARGE ITS FUNCTIONS SATISFACTORILY.

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The following European Gas Works are also using the Condenser with satisfactory results:

St. Mandé; Ternes; Armintières; Reims; Bome; Liège; Schaffhouse; Ivry; St. Denis; Château Thierry; Douai; Florence; Berne; Loclé; Belleville; Versailles; Orléans; Courrières: Geneva; Vevey; Batavia; Frankfort-on-the-Main, and about thirty others.

The Paris Gas Company, sending out a daily December maximum of about twenty-five millions cubic feet, has adopted this Condenser at each of its ten stations.

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as purified, per bushel, on a single test, 10,000 feet of Westmoreland Gas. With revivification lasts indefinitely. Surpasses in POWER and ECONOMY all known materials. Saves largely in FIRST COST, SPACE, LABOR, SUPERINTENDENCE, and all current expenses. Will purify *easily* sulphurous gas, wholly *unmanageable by lime.* Takes out *all the ammonia.* Now operating in the following Gas Works: Harlem, New York (21st street); Port Morris; Hunter's Point; East New York Worcester, Lynn and Cambridge, Mass.; Lewiston, Maine; St, Albans, Vt.; Pawtucket, R. I.; Meriden, Ct., and being introduced in many other places.

Cost 70 cents per bushel. One bushel for each square foot of Purifier sufficient. Rights to use for life of Patents, for daily makes of gas in thousands; under 25,000 $200; under 50,000, $400; under 100,000, $500 $250 additional for each additional 50,000 per day.

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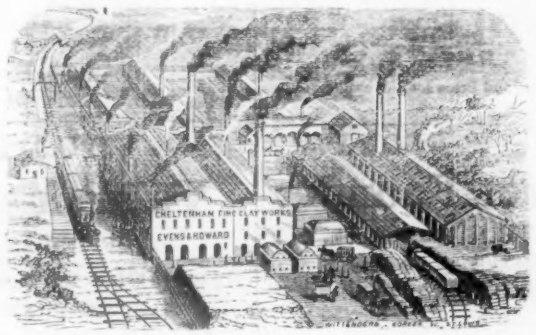

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Gas Consumers' Guide

Enables every Gas Consumer to ascertain at a glance, without any previous knowledge of the Gas Meter, the quantity and money value of the Gas consumed. Also the best method of obtaining from Gas the largest amount of its light.

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The support and confidence of Gas Companies, so long enjoyed by us, encourage us to pursue the same undeviating course that has contributed to establish the character of our house, and with our extended experience and increased facilities, develop the latest improvement that Science can apply, in the construction of Gas Meters, etc., and thereby merit a continuance of the favors hitherto so liberally extended to us, always guaranteeing satisfaction.

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from benches of one to six Retorts each.
WASHERS: MULTITUBLAR AND AIR CONDENSERS: CONDENSERS; SCRUBBERS,
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EXHAUSTERS
for relieving Retorts from pressure.
BENDS and BRANCHES
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and everything connected with well regulated Gas Works, at low price, and in complete order.
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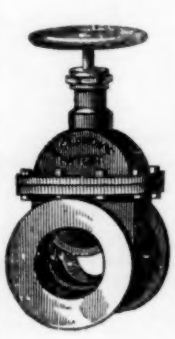

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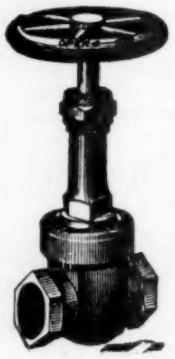

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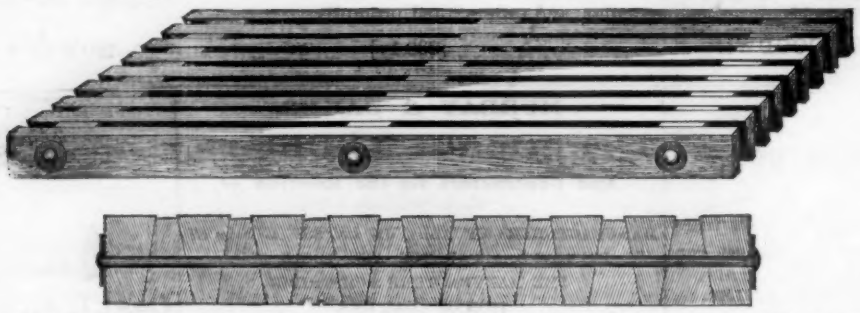

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